EFFECT OF SELECTED NUTRIENT INTAKE AND LEVEL OF PHYSICAL ACTIVITY ON PHYSICAL FITNESS OF A GROUP OF VOLUNTEER MIDDLE-AGED MEN

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CHAPTER I

INTRODUCTION

Medical advances of the last 75 years have increased our life expectancy--made it more probable that we will live out our lifespan--but the lifespan itself has increased very little. In 1900, life expectancy at birth was 42 years; in 1974, it was 71 years. For an individual who attained the age of 65 in 1900, the residual expectancy was 13 years; in 1974, the residual expectancy was 15 years, an increase of only two years (1). Between 1900 and 1974 the diet and lifestyle changed significantly, but the outlook for the elderly changed very little.

One out of every 10 Americans is 65 years or older. The number of persons over 65 has grown at three times the rate of the total population and now constitutes nearly 22 million people (2). Care of the aged accounts for nearly one-third of the nation's health costs. Yet, the greater percentage of this money is consumed in trying to save lives of individuals already stricken with degenerative diseases that have become so common as to be perceived as a natural part part of the aging process. However, Verzar (3, p. 4) states firmly that "old age is not an illness. It is a continuation of life with decreasing capacities for adaptation." The common degenerative diseases are not necessary accompaniments to aging, but are themselves disease states. Solution to the improvement of the health status of the elderly seems to lie in a change of emphasis--a change from treatment of degenerative disease conditions to prevention and control.

Many factors determine health and physical fitness in people. Over some of these the individual has little control; over others he has the power of choice. Nutrition and physical activity are two such factors. Balanced nutrition established early and maintained throughout life has been suggested as one of the best means for minimizing degenerative changes. Animal studies indicate overfeeding early hastens maturity and shortens life; overfeeding after maturity increases incidence of degeneration (33). Cardiovascular fitness is a predictive result of physical activity training (4). The trained individual has endurance to work harder and longer and with less effort than the untrained person. Beneficial lowering of both blood pressure and heart rate and increased lung ventilation and physical work capacity are some of the effects of increased physical activity (8) (14) (35) (36) (39).

Statistics show that most people do not die of old age per se. They die because they have compromised health and physical fitness to over-indulgent living.

Significance of the Study

Aging is associated with many of the changes encountered in people with varying degrees of nutrient deficiency and in conditions of acute loss of physical activity: a diminution of maximal oxygen consumption, an accumulation of body fat, a loss of lean tissue, and a demineralization of bone. However, it is less certain how far these adverse changes are an inevitable consequence of advancing years and how far they are secondary to culturally imposed patterns of nutrient intake and physical activity.

The preamble to the section on nutrition in the report of the 1970 White House Conference on Aging (5) states that all older Americans should be provided with the means to insure that they, too, can enjoy life, liberty, and the pursuit of happiness. In support of this philosophy it was recommended that a major effort be made to research the influence of nutrition on the aging process and diseases during old age (5). Further, the 1970 National Goals and Guidelines for Home Economics Research (6) stated these two areas required investigation: the relation of physical health to nutritional status and the state of nutrition of individuals in selected population groups. Thus, a study to assess the nutrient intake and to identify effects of selected nutrient intake and level of physical activity on physical fitness in a group of middle-aged men seemed consistent with these needs.

Objectives of the Study

The general purposes of this research were to assess the nutrient intake and to identify the effect of selected nutrient intake and level of physical activity on physical fitness of a group of male volunteers from the Oklahoma State University faculty and administration who were part of the ongoing Physical Fitness Research Project conducted by the Oklahoma State University Physiology of Exercise Laboratory.

The specific objectives were as follows:

1. to determine the nutrient intake of each subject in the study;
2. to correlate selected nutrient intakes including total calorie intake, total dietary fat intake, saturated/unsaturated fatty acid intake ratio, and total dietary cholesterol intake with physical fitness level as indicated by maximal oxygen

consumption for each subject;

3. to correlate physical activity in terms of average aerobic points earned per week with his physical fitness as indicated by maximal oxygen consumption for each subject;
4. to correlate total dietary fat intake, saturated/unsaturated fatty acid intake ratio and total dietary cholesterol intake with blood serum levels of total cholesterol and triglyceride for each subject;
5. to determine the relationship of the level of physical activity with level of blood serum total cholesterol for each subject;
6. to correlate level of physical activity with level of blood serum triglyceride for each subject.

Assumptions

This research was conducted on the basis of the following underlying assumptions:

1. The calculated nutrient intakes derived from the four-day food intake record represent typical nutrient intakes of the subjects in the study.
2. The aerobic points system was a valid indicator of relative energy expenditures during various physical activities.
3. The maximal oxygen consumption values were valid measures of physical fitness.

Limitations

The sample for this research was limited to the male volunteers from the Oklahoma State University faculty and administration who were part of the ongoing Physical Fitness Research Project conducted by the Oklahoma State University Physiology of Exercise Laboratory and who completed both the four-day food intake record and the physical fitness testing.

Definition of Terms

For the purposes of this research, the following definitions were accepted:

Physical fitness--The ability to carry out daily tasks with vigor and alertness, without undue fatigue, and with ample energy to enjoy leisure time pursuits and to meet unforeseen emergencies.

Maximal oxygen consumption--The point at which the cardio-respiratory system can no longer increase delivery of oxygen to the working muscles; thus oxygen consumption becomes stable. At this point, the body must be able to metabolize carbohydrates to release energy to the muscles and to build up an oxygen debt.

Aerobic point system--Physical activity classification system based on the rate of oxygen consumption demanded of various activities at various intensities. For example, running one mile in less than 6.5 minutes requires about six times the oxygen consumption as walking the one mile in 20 minutes. Therefore, one point is scored for the 20-minute mile and six points for the six-minute mile with proportional values assigned between the two extremes.

Saturated/unsaturated fatty acid ratio--Ratio of the saturated acid and unsaturated fatty acid content of total dietary fat in which the unsaturated fatty acid portion, obtained by subtraction of saturated fatty acids from total dietary fat, includes both mono and polyunsaturated fatty acids.

CHAPTER II

REVIEW OF LITERATURE

Physical fitness is the right of all people including the aged. It is the "how" to attain and maintain this fitness that forms the basis for this study. In this chapter the literature will concern the following areas: Health and Physical Fitness, Physical Fitness Testing, Nutrient Intake Surveys, Nutrient Intake Assessment, Relationship of Nutrient Intake and Physical Fitness, Relationship of Physical Activity and Physical Fitness, Relationship of Physical Activity and Serum Lipid Levels, and Effect of Nutrient Intake and Physical Activity on Physical Fitness.

Health and Physical Fitness

The World Health Organization defined health as "physical, mental, and social well-being, not merely the absence of disease or infirmity" (7, p. 1). This definition is both difficult to quantify with measures and to interpret with methods for improvement of health. Nevertheless, it is the basis for the President's Council on Physical Fitness and Sports definition of physical fitness. This definition states that "physical fitness is the ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure pursuits and to meet unforeseen emergencies" (8, p. 1). Thus, physical fitness, like health, is a positive quality involving the totality of the individual. Physical fitness is recognized as affecting the individual's physical activity, mental effectiveness, and social adjustments.

A survey study conducted by the Human Population Laboratory of the California Department of Health attempted to provide measurable dimensions to physical fitness as related to an individual's total well-being (9). As a measure of physical health, a seven category scale was developed ranging from severe and lesser disabilities, through chronic and symptomatic conditions to low, medium, and high energy levels. Scale divisions were defined by disease or health characteristics and assigned point values. The scale was applied to the questionnaire responses of 6,928 adults in Alemeda County, California. The scale units were tabulated and analyzed to find that, for all ages, men had better health than women; that a steady decline in health occurred with age; and that only those with distinctly inadequate income had poorer health.

In 1970, coronary heart disease, the major health problem in the United States, killed 660,000 Americans of whom 171,000 were under the age of 65 years. More disturbing is that a number of the "risk factors" associated with susceptibility to coronary heart disease could be modified and yet, are still prevalent. Health practices such as diet, physical activity, and smoking, are under individual control and therefore, could be changed to better physical fitness, to prolong productivity, and to minimize risk of disease.

The second part of the Human Population Laboratory study in California was an analysis of the data to test the relationship of particular health practices to physical fitness (9). The factors considered were sleep, eating patterns, weight status, physical activity, alcoholic beverage consumption, and smoking. Significantly, it was found that the physical fitness of the sample increased and mortality rates decreased consistently with the number of health practices observed. For men, 8.8 times as many died among those with three or fewer health practices as compared to those with all seven practices. The mortality rates for both sexes observing three or less health practices were at least twice as high as for those observing five or more. The life expectancy for men at age 45 years in the zero to three health practice group was 21.6 years as compared with 33.1 years for those in the six to seven health practice group, an increase of 11 years.

Utilizing the Index of Psychological Well-Being, the California Human Population Laboratory found a positive relationship between physical and mental health (9). Those scoring higher on the physical health scale also tended to score higher on the Index of Psychological Well-Being. Social health, measured by the instrument designed to quantitate the degree to which an individual is a functioning member of his community, was also positively related to physical health. Thus, the study pointed out that physical, mental, and social health were all interrelated. As physical health increased (through observance of an increased number of health practices), mortality decreased, life expectancy increased, and social and mental health increased.

For the purposes of this study the researcher further investigated the literature for the relationship of two health practices--nutrient intake and physical activity--to two indices of physical fitness--maximal oxygen consumption and blood serum levels of cholesterol and triglyceride.

Physical Fitness Testing

Capability of the individual to carry out daily tasks with "vigor and alertness" as the definition of physical fitness prescribes is ultimately dependent upon the body's ability to supply oxygen to the working muscles (10). Therefore, maximum physical fitness reflects the capacity of the cardiovascular system to transport oxygen to the tissues and the tissues' ability to take up this oxygen and utilize it in the production of energy. Physical fitness is then directly measured by the oxygen intake during maximal workloads.

Hill (11) demonstrated that there is a linear relationship between oxygen intakes and workload until maximal oxygen consumption is reached. He showed that at this point further increases in workload only resulted in increases in oxygen debt and not in oxygen consumption. Maximal oxygen intake can then be predicted by extrapolation of the slope of the submaximal oxygen intake versus pulse rate values to an assessed maximum pulse rate.

Astrand and Rhyming (12) designed a submaximal test and nomogram for prediction of maximal oxygen intake based on the linear relationship hypothesis. Criteria for their test included that the test workload selected had to be relatively high and that the duration of the test had to be long enough to permit adjustment of the circulation and ventilation to the exercise. Taylor et al. (13) added that test conditions must be such that motivation and skill of the individual were not limiting factors to the individual's performance of the test.

The Balke Treadmill test not only meets these criteria, but also is a standardized test that has been used extensively in research studies for measurement of physical fitness in terms of maximal oxygen consumption (14) (15) (16) (17). The Balke Treadmill test involves a gradually increasing workload and requires only walking skill. It is a submaximal workload test; and therefore, it is not necessary to bring a subject to a state of near exhaustion to measure his maximal oxygen consumption.

Nutrient Intake Surveys

Complete nutritional status evaluations are necessary for defining the nutritional conditions of selected segments of the population and for the design of adequate intervention programs. Johnson and Nitzke (18) studied the nutrient intake of a group of 169 women in Wisconsin and found that percentages of women with nutrient intakes of less than 55 per cent of the R.D.A. ranged from 21 per cent in the case of vitamin A to 79 per cent in the case of pantothenic acid. Twenty per cent of the women had nutrient intakes low in pantothenic acid, magnesium, iron, vitamin B_6, calcium, and vitamin A. The women ranged in age from 20 to 60 years old. Dietary food records and a computer program based on the food composition tables were used for nutrient intake assessment.

In the survey of the original subjects of the 1948 San Mateo County diet study, 273 subjects with a mean age of 75 years were re-assessed for dietary intakes. Steinkamp (19) used one-day records of food intakes for evaluation of nutrient intake. Nutrient intakes were compared with the 1964 revised Recommended Dietary Allowances. Results of this study showed that men consumed, on the average, less than the R.D.A. for calories; women consumed about equal to the R.D.A.. Food intakes were found to generally decrease with increased age. Protein was consumed about equal to the R.D.A.. Only calcium and niacin were consumed significantly less than the R.D.A.. All other mean intakes indicated consumption equal to or greater than 100 per cent of the R.D.A.'s. Individually, calcium, vitamin A, niacin, and vitamin C were the nutrients with the highest percentage of the subjects consuming less than two-thirds of the R.D.A.'s. For niacin, 66 per cent of the subjects consumed less than two-thirds of the R.D.A.; for calcium, vitamin A and vitamin C, 25 per cent consumed less than two-thirds of the R.D.A.. No subject had intakes less than two-thirds of the R.D.A. for iron.

In summary, the study by Steinkamp (19) revealed that most persons consumed approximately the R.D.A. for calories. Thirty-one per cent of the subjects were found to be greater than 10 per cent overweight. Food intake was found to decrease with age. A large proportion of the individuals consumed low intakes of specific nutrients particularly niacin, calcium, vitamin A and vitamin C. Of the 217 subjects who died between the first survey in 1948 and the resurvey in 1962, 67 per cent died of cardiovascular disease.

Fry et al. (20) conducted a study of 32 healthy women over 65 years of age. Seven-day dietary records were used for evaluation of nutrient intake. Results showed that mean daily intakes of calories and all nutrients studied, except iron, equaled or exceeded 100 per cent of the respective R.D.A.'s. Individually, no subject had calorie intakes less than two-thirds of the R.D.A.. Mean percentages of the total calories furnished by protein, carbohydrate and fat were 16, 34, and 50 per cent respectively. Iron, calcium, and vitamin A were consumed at less than satisfactory levels in the diets of 12, 16, and 9 per cent of the women respectively. However, calcium was the only nutrient consumed in amounts less than one-half of the R.D.A.. This occurred in the diets of two women. Average nutrient intakes generally decreased slightly with increased age.

Like the study conducted by Steinkamp (19), the study by Fry et al. (20) showed a general decrease in consumption of all nutrients with decreased age. Incidence of low intake levels of calcium and vitamin A were again evident. Calorie consumption was greater than two-thirds of the R.D.A. in all cases. Incidence of weight status was not stated, but the mean weight for the 32 women was 134 pounds and the mean height was 64 inches. Twelve per cent of the women consumed less than two-thirds of the R.D.A. for iron.

In Cleveland, Ohio, Bebb et al. (21) studied the nutritive content of the usual diets of 82 men ranging in age from 23 to 62 years. Fifty-four men employed in executive or management positions were placed in Group I. Twenty-eight men, also executives, who were participating in a community physical fitness program were placed in Group II. Three-day food intake diaries recorded at monthly intervals throughout the one-year study were used for assessment of average subject nutrient intake. Results of the study showed that there were wide variations among individuals in the study. More individuals in Group II consumed less than two-thirds of the R.D.A. for calories than Group I. Mean percentages of calories consumed as protein, carbohydrate, fat and alcohol were, for Group I, 15.4, 36.9, 37.8 and 9.9 per cent respectively, and for Group II, 17.7, 39.2, 40.0 and 3.1 per cent respectively. Group II showed a significant decrease in the consumption of alcoholic beverages. All subjects had intakes of iron and thiamine greater than two-thirds of the R.D.A.'s. Less than two-thirds of the R.D.A.'s for vitamin A, calcium, and vitamin C were consumed by 39, 20, and 15 percent of the subjects respectively.

Results of this study revealed incidences of consumption less than two-thirds of the R.D.A. for calories. Mean consumption of calories as fat ranged from 36.9 to 39.2 per cent. Vitamin A, calcium, and vitamin C were most often found to be consumed less than two-thirds of the R.D.A..

Nutrient Intake Assessment

How to obtain accurate food intake data and how to most effectively evaluate the nutrient composition of the foods consumed have been the focal problems for a number of researchers. In the 1950's, Young et al. (22) (23) studied the relative reliability of the dietary history, the 24-hour recall and the seven-day food record research techniques. Data collected in three northwestern states participating in a cooperative nutritional status study was used to compare dietary methods. Statistical comparison of the regression coefficients led to the conclusion that the 24-hour recall could not be substituted for the seven-day record method in obtaining data about individual nutrient intake. Only if the data was to be used for describing groups of 50 or more persons, the 24-hour recall method could be substituted for the time consuming seven-day record method. Information obtained from the two methods could not be interchanged unless describing the mean intake of a group, not individuals.

Chalmers et al. (24) investigated the questions as to which days could be used for assessment of "typical" intakes and how many days were needed for accurate assessment of typical intakes. Intercorrelation of the data obtained from 28-day, 14-day, and 7-day records revealed that there was no association between days. Therefore, consecutive days must be considered independent and only one-day food intake records were necessary. To increase the accuracy of mean nutrient intake for a group, an increase in the number of subjects should be made, not the number of days.

Young et al. (22) concluded from a study of the numerous errors possible in dietary survey, that probably the largest source of error is the estimation of portion sizes. Most accurate portions were given for countable items like bread slices, cookies, eggs, and for measurable items like beverages. Most inaccurate portions were estimated for sauces, puddings and fruit. Subjects usually had a tendency to overestimate food portions.

Methods of judging food intake ranged from direct biochemical assay of homogenates of daily food intake to calculation of nutrient content from standardized tables of food composition. Marshall et al. (25) investigated the question whether nutrient values from composition tables could be used with assurance when calculating diets. Food intakes of 21 healthy volunteers ranging from 50 to 60 years of age were analyzed by biochemical assay of homogenates and by food composition table calculations. They concluded that although differences in the two methods were found to be statistically significant at the $< .01$ level in most nutrients, the differences were "in practice" insignificant.

Information from dietary intake studies has been presented in reports in a variety of ways. Davis et al. (26) reviewed American dietary studies between 1950 and 1969 and found that presentation of the data varied and was incompatible. Most of the nutrient intake studies presented their data in terms of percentage of subjects whose nutrient intake was equal to or greater than 100 per cent of the R.D.A.; above or below two-thirds for R.D.A.; above or below one-half of the R.D.A.. They suggested establishment of a standardized format for data presentation.

Relationship of Nutrient Intake and Physical Fitness

Proper nutrition throughout life has been suggested as one of the best means of minimizing degenerative changes and superimposed diseases. However, as Howell and Loeb (27) clearly indicate that where malnutrition and deficiency disease are prevalent, there is ease in drawing conclusions concerning the effects of substandard nutritional status. It is rather the more subtle relationship between food intake of a diet that protects the individual from disease and prolongs life and subsequent health status that is more difficult to define. The possibilities of some relationships between aging and dietary insufficiencies is suspected by the fact that a variety of deficiency states result in conditions which simulate those encountered in the aged. This observation only suggests that certain deficiencies may accelerate or intensify aging. In England a 1965 survey of the health among elderly women living alone in London showed the majority of those in poor health also had inadequate diets (28) (29). Subclinical deficiency states were found which reflected low ascorbic acid, vitamin D, and thiamine intakes. X-ray analysis revealed 25 per cent of the women surveyed had increased bone rarification and when compared with age matched subjects were found to have a significantly lower vitamin D intake. The researchers concluded that osteomalacia in England was a distinct and preventable nutritional disease in the elderly, not a condition caused by aging.

Research has evidenced a relationship between nutritional adequacy early in life to health and well-being in later life. Kelley et al. (30) at Michigan State University studied 97 white and 104 black women between 40 and 80 years of age. Of the women surveyed, 95 per cent had intakes less than 80 per cent of the R.D.A. for one or more nutrients and 40 per cent of this group reported unexplained tiredness, pains in joints and shortness of breath. The mortality rate in the succeeding seven years was higher among those whose intakes had been below 40 per cent of the R.D.A. for one or more nutrients.

In a double-blind study of 35 elderly subjects ranging in age from 65 to 90 years, Rafsky (31) observed that upon administration of vitamin B_{12} the previously complained about feelings of fatigue disappeared in 89 per cent of the participants. Upon replacement of the vitamin with an inert substitute, the symptoms returned.

To secure some long term effects of nutrient intake on the health of older people, Schlenker (32) re-examined the 28 survivors (now 64 to 90 years of age) and death records of the remaining 69 women who were first studied in Lansing in 1948. A comparison of the age at death with fat content of the past dietary intake data suggests a high correlation with the fat content of the diet. The higher the diet level of total fat, the younger the age at death. Conversely, the higher the level of carbohydrate as percentage of total dietary calories, the lower the percentage of dietary fat calories and the longer the life span.

Evidence from animal studies supports the deleterious effects on health and well-being of high intakes of dietary fat. Schemmel (33) investigated the effect of diet in early life upon subsequent weight of the body and its composition. Comparison of rats suckled by dams fed high fat (60 per cent) diet to those suckled by dams fed high grain (three per cent fat) diet were made. On weaning, one-half of each group of animals was fed either the high fat or grain diet for 168 days. No deaths occurred in the group that was suckled by grain-fed dams and subsequently fed grain diets. The largest number of deaths occurred among the animals nursed by high fat fed dams, then, after weaning, fed high fat ration. Intermediate death rates occurred in the other two groups. The results indicated that high levels of fat intake reduced longevity.

Houston (34) evaluated the food habits of 30 hospitalized elderly male patients to determine the influence of past food habits upon present health status. A questionnaire, 24-hour recall, and an attitude assessment were the evaluation instruments. Illnesses associated with past food habits included cardiovascular disease in 33 per cent of the cases, diabetes in 10 per cent of the cases, hemorrhoids in 6 per cent of the cases, and gallstones and bowel blockage in 3 per cent of the cases.

Work output of individuals with increased nutritional status has been found to be higher with those with higher rather than lower nutritional status. Satyanarayana et al. (35) studied the relationship between work output and anthropometric, biochemical and socioeconomic variables in 57 male industrial workers in India. Workers were studied for three months and their daily output of work was carefully measured in terms of number of line items produced each day. Clinical and biochemical examination indicated that the current nutritional status was adequate. Among the parameters studied, only body weight and lean body weight were significantly correlated with work output even after removal of the influence of height by partial correlation. Total daily work output was significantly higher in those workers with higher body weight and lean body weight. The implication was that low nutritional status that leads to low adult body weight and low lean body weight may be associated with reduced adult work output.

Spur et al. (36) demonstrated that production among sugar cane cutters was positively related to body size, leanness, and to maximal oxygen consumption. Forty-six Columbian sugar cane cutters, aged 18 to 34 years, were involved in this study. Although present nutritional status was judged to be adequate at the time of the study, previous nutritional status effect on height, weight, and leanness was found to be related to current work output. Thus, childhood malnutrition costs in terms of work output as an adult. Evidence was also presented that a higher percentage of oxygen consumption has to be utilized to maintain production level as the worker ages.

Relationship of Physical Activity and Physical Fitness

The primary objective of a physical activity program with middle aged subjects is to increase physical fitness and thereby, delay (or even reverse) the onset of physical deterioration. Characteristics of physical fitness positively affected by increased levels of physical activity include physical working capacity, cardiovascular function, body composition and personality traits. As is shown in the study of 47 women aged 20 to 69 years by Wessel (17), aging untempered with physical activity is characterized by an increasing inability to adjust to exercise stress. Test results of a submaximal treadmill test at zero per cent grade, three miles per hour for 10 minutes and a monitored recovery period revealed that there was a consistent trend for oxygen uptake, oxygen pulse, and lung ventilation to increase with age throughout the exercise and the first two minutes of recovery.

Effects of physical activity on physical work capacity was studied by Ogirimah (16) with a group of 22 men aged 38 to 50 years who had recent history of myocardial infarction. Subjects were randomly assigned to either the "joggers" or to the "games" group. Heart rates during physical activity were studied and the period for which the heart rate was greater than 130 beats per minute was estimated. Results showed that the heart rate during jogging was significantly higher than the rate during games activities. Improved physical working capacity for the "joggers" group was shown by significantly increased treadmill walking time. Clinical symptoms of angina pectoris decreased for subjects in the "joggers" group.

In a study conducted by de Vries (37), in 1970, 112 men aged 52 to 87 years participated in a vigorous exercise training program. Workout sessions, including calisthenics, jogging, and swimming, lasted one hour three times per week. Results showed a 29 per cent improvement in the oxygen pulse at near maximal workload. As a result of the significant improvement shown in physical work capacity as measured on the bicycle ergometer, de Vries concluded that the trainability of older men with respect to physical work capacity was greater than had been expected and did not depend upon prior physical training during youth.

Cardiovascular improvement as a result of increased physical activity was shown in a study by Elder (38) with 83 volunteer male subjects aged 24 to 72 years. The program consisted of continuous, rhythmical exercises and jogging, 30 to 45 minutes per day, three days per week for three months. The Cameron Heartometer and the Cureton Progressive Pulse Ratio Test were used to determine the level of cardiovascular fitness. The results showed significant improvement of cardiovascular efficiency in 9 out of the 13 tests used as a result of the exercise program.

Wilmore et al. (39) determined body composition changes of 55 men between the ages of 17 and 59 years as a result of a 10-week jogging program. Sessions were 24 minutes per day three times per week. At each session the subjects were encouraged to increase the distance or decrease the time for a given distance. Body composition tests were body density by hydrostatic weighing, seven skinfolds and two girths. Results showed small but significant alterations in body composition. Body weight decreased about one kilogram with no change in lean body weight. Body density increased and percentage of body fat decreased. Four of the seven skinfolds decreased. Abdominal girth decreased.

Body composition was studied by Sidney et al. (40) in subjects over 60 years old enrolled in a predetermined program of endurance training. The program consisted of four one-hour periods of supervised self-prescribed walking and jogging. Estimated energy cost of the activity patterns was 150 to 200 kilocalories per day. As a result of seven weeks of conditioning, maximum oxygen intake was increased to 30 per cent. Body composition changes seen after one year of conditioning showed 17 per cent loss of average skinfold thickness, 10 per cent increase in lean body tissue, 13 per cent increase of knee extensive force, 4 to 5 per cent increase in body potassium and apparent halt of normal age-related loss of bone calcium. Extent of individual change was dependent on the intensity and frequency of activity.

Physical fitness as it relates to the total well-being of man also includes psychological and social health. Physical activity has been found to influence personality characteristics in studies such as the one conducted by Buccola and Stone (41). Subjects were 36 men aged 60 to 79 years who were engaged in either a jogging or a cycling program. Training included 25 to 50 minutes per day, three days a week sessions. Results showed significant increase in predicted oxygen intake, and decrease in blood pressure and weight for both groups. There was an increase in flexibility for the joggers and a decrease in per cent body fat for the cyclers. After 14 weeks no personality change was seen in the cyclers, but the joggers became less surly and more self-sufficient.

Tharp et al. (42) also demonstrated differences in personality characteristics as a result of physical activity. For this study, subjects from the YMCA and the University of Nebraska were classed as "trained" and "non-trained" based on their prior physical activity. All subjects were administered the physical work capacity and two psychological tests: Multiple Affect Adjective Checklist and Cattell's 16 Personality Factor test. The physical work capacity test established that the trained individuals had significantly higher levels of physical fitness than the untrained individuals. The psychological tests' results showed that the trained subjects had significantly lower levels of anxiety and depression than did the untrained, and that the trained subjects were significantly more conscientious, more relaxed, more self-assured, more secure and more emotionally stable than were the untrained subjects.

Relationship of Physical Activity and Serum Lipid Levels

Diverse and inconsistent results have appeared in the literature concerning the effects of physical activity on levels of serum cholesterol and triglyceride. In 1968, Mealy (43) studied the effects of exercise on the risk factors of coronary heart disease in two groups of 35 male administrators at the Johnson Space Center. Results suggested that modification of selected coronary heart disease risk factors in the group that exercised at least three times per week for 15 minutes at a heart rate of 150 beats per minute reduced the risk of developing coronary heart disease (CHD). However, the correlation coefficients did not support the association of levels of physical fitness as measured by maximal oxygen intake with the CHD risk score. Body weight and serum cholesterol levels appeared to be decreased as a result of the exercise.

In another study of the effects of metered physical activity on serum lipids of adult men aged 28 to 54 years, Milesis (44) found that physical activity expending 6.54 kcal/kg. four days a week caused a favorable but not a statistically significant reduction of serum cholesterol and small increase in triglyceride. Activity included a continuous interval running, jogging and rhythmic calisthenics program.

Pollock et al. (45) randomly assigned 13 volunteer men aged 30 to 47 years to each of two groups. Group I engaged in physical activity two days per week and Group II, four days per week for 16 weeks. Activity periods were 30 minutes in duration and consisted of continuous walking, jogging, or running. Group III, the control group, consisted of seven sedentary men who were also tested. Diet was evaluated through selected nutrient analysis from a series of three day diet recalls. Results showed that serum cholesterol and triglyceride values for Group III remained constant, that serum triglyceride concentrations decreased significantly over the first eight weeks, but not over the full 16 weeks. A comparison of the two experimental groups showed no between group differences. Body weight losses were also insignificant.

In a 20-year longitudinal study instituted by Golding (46), in 1960 at Kent State University, the effects of physical activity on blood cholesterol levels were studied. During the first year, 45 men participated; the following year more subjects were added. The third year the first two groups were combined and a new group begun. This procedure was continued annually. Testing included body fat percentage, physical work capacity, cardiovascular function, and serum cholesterol level. Physical activity included a progressively more intense swimming and calisthenics program with 30 to 45 minute sessions three times a week. Results showed significant reductions in the slightly high initial serum cholesterol levels during the first, second, and third years. During the fourth and fifth years the cholesterol level increased, although it was maintained at a significantly lower level than the original level. During the seventh year, jogging was added to the program and cholesterol levels dropped significantly. Weight did not change significantly during the 10-year period although body composition decreased in percentage of fat.

Tooshi (47) formed on control and three experimental groups, each containing eight to nine men, 27 to 45 years of age. The experimental groups participated five days per week for 20 weeks in progressive endurance programs including nonstop walking, jogging, and running. The type of physical activity was the same for all experimental groups, but the duration varied from 15, 30, to 45 minutes. The group participating 45 minutes per day had a significantly greater reduction in blood cholesterol than did all other groups; the cholesterol reduction for the 30-minute group was greater than for the control and the 15-minute groups. The cholesterol levels of the latter two groups did not change significantly.

At the University of California at Santa Barbara, Rochelle (48) monitored the blood plasma cholesterol levels of six experimental and six control adult males during a five-week training program. The training consisted of a two-mile run for time, five days per week. An eight-week detraining program followed. Cholesterol levels were found to be significantly reduced during the course of the training. The levels of plasma cholesterol returned to pretraining levels within four weeks after the cessation of exercise.

Using the questionnaire-interview method, Montoye (49) assessed the amount and intensity of physical activity of men aged 20 to 64 years in Tecumseh, Michigan. The sample included 1,696 men whose activity levels were classified as sedentary, moderately active, or active based on occupational and leisure time activity. Serum cholesterol levels were found to be significantly lower in the active men, but to significantly increase with increased age of the subjects.

Upon review of studies concerning the effects of physical activity programs on serum lipid levels, Cureton (50) concluded that physical activity may reduce serum cholesterol level if the work involved is long enough, hard enough and of the cardiovascular endurance type. Low gear programs have been seen to be relatively ineffective in reducing serum lipid levels. Some reductions are obtained with middle gear activities such as walk-jog programs. Work continued for one hour a day seven days per week and continued for longer than six weeks begins to have beneficial effect on serum cholesterol level. The high gear programs of continuous, rhythmical type running or swimming in which weight is lost and a negative caloric state is induced are seen to be the most consistent in significantly lowering blood serum cholesterol levels. This type of exercise must be continued for one hour a day for five days a week.

According to this classification system, Golding's (46) training program would have been classed as high gear and would have been expected to reduce serum cholesterol levels. Rochelle's (48) program would also have been classed as high gear. However, the return of serum cholesterol to original levels after program cessation would seemingly underline the fact that even high gear programs must be continued for long periods of time to effect a permanent change in serum levels.

The exact role of serum triglyceride in the incidence of coronary heart disease has not been clarified. However, some researchers believe that serum triglyceride levels are more indicative of coronary heart disease risk than serum cholesterol. Albrink et al. (51) found serum triglyceride levels greater than 5.4 milliequivalents per liter in five per cent of healthy men in their twenties, in 36 per cent of healthy men over 30 years old, and in 82 per cent of all patients with coronary heart disease. At all ages, the most consistent lipid abnormality was an elevated triglyceride concentration and not a high cholesterol level.

Research studies have shown that lowered level of serum triglyceride is an acute result of exercise. The lowering effect is apparent within a few days and is dissipated within 48 hours upon cessation of exercise. The effects of an exercise program were studied with a group of 14 occupationally sedentary men aged 35 to 55 years at the University of Illinois by Holloszy et al. (52). The program consisted of a progressive calisthenics running program maintained at a level of at least three sessions per week for six months. All but one subject showed a reduced serum triglyceride concentration at the end of the study. The mean triglyceride value decreased from 208 milligrams per 100 milliliters (mg./100 ml.) to 125 mg./100 ml.. At completion of the first six-month period several men with initially elevated triglyceride levels remained sedentary for five to six days. Regular eating patterns were continued as usual. Triglyceride levels were tested and resulted showed that the level had risen 150 mg./100 ml.. Within three hours following a three-mile run, triglyceride levels decreased in three of the men; within 20 hours, the level decrease was evident for the fourth. Tested 44 hours after the three-mile run, the reductions were still present.

Effect of Nutrient Intake and Physical Activity on Physical Fitness

There are limited studies reported in the literature concerning the effect of nutrient intake and physical activity on physical fitness. It is generally accepted that nutrient intake directly affects health and physical fitness as it is generally accepted that physical activity directly affects health and physical fitness. Both theories are based on the findings of numerous studies presented in the literature as seen in previous sections. Hence, it would seem logical that the combined effects of nutrient intake and physical activity would be greater than the effect of either single variable. This hypothesis has not been adequately tested.

At Harvard, Mann (53) studied over a 10-week period the effect of increased caloric intake on serum cholesterol levels when excess calories were burned through exercise and when excess calories were deposited as fat. Results showed that when the caloric intake of three men was doubled, body weights and serum cholesterol levels returned to pre-experimental levels. The subjects were again "overfed", but this time subjects were exercised on a treadmill at an intensity controlled to burn the extra calories. Results showed that the doubling of the calories had no effect on serum cholesterol levels when the excess energy was used in increased physical activity. When physical activity was restricted and fat accumulated, the serum cholesterol levels approximately doubled.

Cureton (50) interprets the interrelatedness of diet and exercise in the Mann study by suggesting that food reduction caused weight reduction which, in turn, caused serum cholesterol levels to fall. Once these were normal, exercise of sufficient intensity and duration maintained the lowered serum cholesterol levels. The question that needs to be asked is "what would be the long term effect of both controlled caloric intake and controlled level of physical activity?".

Zuti (54) conducted a study pertaining to the physiological effects of fat reduction and exercise on women aged 25 to 45 years. Tests included anthropometric measurements, prediction of working capacity at a heart rate of 170 beats per minute on a bicycle ergometer and blood lipid determinations. Programs for the three groups of 11 women were designed to achieve a reduction of 500 calories per day over normal activities as follows: Diet Group, diet reduction only; Exercise Group, exercise requiring 500 calories, no change in regular diets; Diet-Exercise Group, 250 calorie reduction in diet, 250 calorie loss through exercise. The program consisted of walking, jogging, bench stepping, and calisthenics. Results showed that all groups lost weight with no significant differences between groups. Significant changes in body composition occurred with both Exercise groups showing greater reduction in body fat than the Diet Group. The Diet Group showed an undesirable loss of lean body tissue. Girth measures showed significant losses regardless of the group. Exercise groups showed significant increases in circulatory-endurance scores, while the Diet Group did not. Serum lipids were significantly reduced; differences between the groups were not significant.

Therefore, at the level of physical activity and caloric reduction levels in the study, the combined effect of diet and exercise control was not significantly different than the effect of exercise control alone. Results of diet control alone showed undesirable loss of lean body tissue.

Various medical treatments for peripheral vascular diseases have been tried with little success. The common symptom of this disease is intermittent claudication with all its inherent dangers of generalized atherosclerosis. Pritikin et al. (55), in a six-month study supported by the Longevity Research Institute and the Long Beach Veterans Hospital, monitored the progress of two groups of 19 patients with peripheral vascular disease. Coexisting diseases in both groups included angina, hypertension, cerebral ischemia, diabetes, arthritis, gout, congestive heart failure, and hyperlipidemia. Subjects in both groups were advised to take walks of at least 15 minutes two or three times daily as a minimum, and, if possible, every hour. They were also encouraged to abstain from use of tobacco and alcoholic beverages. The control group was administered a diet of 20 per cent protein, 40 per cent fat, 48 per cent carbohydrate and 300 milligrams of cholesterol. The experimental group was given a diet of 10 per cent protein, 10 per cent fat, and 80 per cent complex carbohydrates and no cholesterol. Treadmill tests were used to measure improvement in distance walked. Starting treadmill pace was 1.5 miles per hour (mph) with a constant two per cent grade. Pace was increased by 0.75 mph every 30 minutes. Baseline test results showed that no subject could walk for the first 30 minutes at 1.5 mph. Results of the six-month study revealed that the control group had increased treadmill walking time by 302 per cent; the experimental group by 5,870 per cent. For the experimental group, degenerative disease symptoms returned to normal for: 100 per cent of patients with angina, diabetes treated by oral hypoglycemics, gout, arthritis, hyperlipidemia; 75 per cent of those with hypertension and diet controlled diabetes; 50 per cent of those with insulin-dependent diabetes and congestive heart failure. Angiographic studies revealed some incidence of plaque reversal. No changes in degenerative conditions were found in the control group. The combined effect of both nutrient intake control and physical activity control to the physical fitness of the peripheral vascular disease patients was astounding.

CHAPTER III

PROCEDURE AND METHODOLOGY

The purposes of this chapter were to present the procedures used to identify the sample, to describe the methods used to obtain the data, and to outline the analyses of the data which enabled the researcher to attain the objectives of this research.

Selection of the Sample

The population for this study was limited to the 85 male volunteers from the Oklahoma State University faculty and administration who were subjects in the ongoing Physical Fitness Research Project conducted by the Oklahoma State University Physiology of Exercise Laboratory. Due to summer vacations and out-of-town conferences, only 45 of the original 85 subjects responded to the request for participation. Of the 45 respondees, 13 failed to complete both the four-day food intake record and the physical fitness testing; and therefore, were not included. The 32 remaining subjects, having completed both the food intake records and physical fitness testing, comprised the sample for this study and ranged in age from 31 to 62 years and had a mean age of 46.2 years.

In June, 1977, each of the original 85 subjects was mailed a packet of information introducing this study and asking for their individual participation. The packet (Appendix A) contained a letter of introduction explaining the purpose and the methodology of the study and a copy of each of the following:

1. instructions for completing the personal data questionnaire,
2. the personal data questionnaire,
3. detailed instructions for filling out the food intake record forms,
4. the food intake record forms,
5. instructions for having the venous blood sample drawn,
6. the consent form to have been signed by the individual subject allowing for such a sample to be drawn, and
7. the data request form by which the subject could request a copy of the results of the study.

Subjects were requested to return completed forms to the researcher by campus mail using the coded self-addressed envelopes.

Development of the Personal Data Questionnaire

The personal data questionnaire was developed by the researcher to obtain background information of the individual subjects, to aid in determining the health status of the individual subjects, and to provide information of specific eating habits of the individual subjects. The questionnaire statements were reviewed by four Oklahoma State University faculty members--two in nutrition, one in research methods, and one in physiology of exercise. The evaluators suggested the rewording and omission of and addition to some of the statements in the questionnaire. The revisions were made by the researcher.

The revised personal data questionnaire was pretested with five middle-aged men. Since no difficulty was experienced by the pretest subjects, the same revised questionnaire was sent to each of the 85 original subjects in the Physical Fitness Research Project (Appendix A).

Four-Day Food Intake Record Analysis

Once the completed food intake record forms were received by the researcher, each of the subjects was contacted by telephone to set up an appointment for a personal interview. The interview was used to clarify any of the food items recorded on that subject's food intake record form and to take a 24-hour recall. The food intake data from the 24-hour recall was treated in the same manner as the four-day intake record data. The totals for each of the selected nutrients were used to check the reliability of the four-day food intake records for each individual subject.

Each food item listed on the food intake records was coded according to the numerical system used in the United States Department of Agriculture Home and Garden Bulletin Number 72 (56). An existing computer program at the Oklahoma State University Computer Center was used to obtain a data printout listing calories and selected nutrients for each food coded. The nutrients included the following: protein, calcium, iron, vitamin A, thiamine, riboflavin, niacin, and ascorbic acid. Church and Church (57) was used to obtain the nutrient information for those foods not listed in the bulletin. Total fat, saturated fat, and cholesterol content of all foods were also identified. Calories and nutrient values were totaled and averaged for each subject for the four-day food intake period. Saturated to unsaturated fatty acid intake ratios and per cent of calories as total fat intake were calculated.

Blood Lipid Analysis

Twelve-hour fasting venous blood samples of 10 milliliters were drawn by the laboratory technician at the Oklahoma State University Student Health Center from 27 of the 32 subjects in the research sample. The blood samples were centrifuged at 3000 revolutions per minute for 10 minutes, refrigerated at five degrees centigrade and then analyzed for serum cholesterol according to the method established by Bloor (58) (59). The samples were again centrifuged at 5000 revolutions per minute for 10 minutes and the serum was reserved in freezer storage for serum triglyceride determination using the method as outlined in the Sigma Chemical Company Technical Bulletin No. 405 (60). The remaining sample was discarded. All colorimetric determinations were made using the Beckmann D. U. Spectrophotometer.

For the serum cholesterol determination, one milliliter of serum was pipetted into a labeled 50 milliliter glass stoppered volumetric flask. To the serum sample, 40 milliliters of alcohol-ether mixture (see Appendix B) was added slowly while agitating the flask continuously. The flask was then stoppered and shook for one minute. Flask contents were heated in a hood on a hot plate to just boiling and then cooled to room temperature.

When cooled, the flask contents were diluted to 50 milliliters with the alcohol-ether solution and mixed thoroughly. The contents were then filtered into labeled 50 milliliter beakers. Ten milliliters of the filtrate were evaporated to dryness on a hot plate. Temperature was not allowed to exceed 60 degrees centigrade.

Cholesterol was extracted from the residue with dry chloroform (see Appendix B). Three milliliter portions of dry chloroform were added to and boiled with the residue. This was decanted into labeled 10 milliliter graduated glass stoppered cylinders. The process was repeated four times. Total volume of the extracts was maintained at a level less than five milliliters. The extract was then diluted to five milliliters with dry chloroform. Five milliliters of the dry chloroform were used as the "blank" for the basis of comparison in the colorimetric assay.

To each cylinder two milliliters of dry acetic anhydride and 0.2 milliliters of concentrated sulfuric acid (see Appendix B) were added. The contents of all cylinders were mixed carefully. With the "blank" in the Beckmann D. U. Spectrophotometer and the wave length set at 630 nanometers, the instrument was "zeroed". In exactly five minutes after the addition of the sulfuric acid, the readings were made. The instrument was "zeroed" between each reading.

Sets of five serum samples and one standard were assayed in duplicate for each set of determinations. Values for the duplicates for each sample were averaged for the resulting serum cholesterol value. Serum cholesterol determinations were made from the standard curve calibrated from specific dry chloroform dilutions of a stock solution of cholesterol. Readings were made on the Beckmann D. U. Spectrophotometer with the wave length set at 630 nanometers.

For the serum triglyceride determination, 0.8 grams ($\pm$ 0.2 grams) triglyceride purifier (see Appendix B) were added to 16 by 150 milliliters straight-sided test tubes. To a test tube labeled "blank" 5.0 milliliters of isopropyl alcohol and 0.2 milliliters of distilled water were added. To a test tube labeled "standard" 4.8 milliliters isopropyl alcohol, 0.2 milliliters distilled water and 0.2 milliliters triolein standard (see Appendix B) were added. To test tubes labeled with the individual subject's identification 5.0 milliliters isopropyl alcohol and 0.2 milliliters serum were added. Tubes were swirled while serum was being added.

All test tubes were set on a mechanical mixer and shook for five minutes. Tubes were allowed to stand until the absorbent began to settle and then were given a single sharp snap of the wrist to facilitate the washing down of most of the solids to the bottom of the respective tubes. The tubes were then centrifuged at 3000 revolutions per minute for five minutes to obtain a clear supernatant.

Duplicate clean test tubes were labeled and 2.0 milliliters of the clear supernatant were transferred by pipette to the correspondingly labeled test tube. Into each tube 0.5 milliliters of potassium hydroxide solution (see Appendix B) was pipetted. Resultant test tube contents were mixed by swirling and incubated at 60 degrees centigrade for five minutes. Tubes were then cooled to room temperature by placing in a cool water bath.

To each test tube 0.5 milliliters periodate solution (see Appendix B) were added. Each test tube was mixed immediately after the addition. Ten minutes lapsed from the first addition to the first test tube and then 3.0 milliliters color reagent (see Appendix B) were added to each tube. Again, the contents of the tubes were mixed after each color reagent addition.

Test tubes were covered with polyethylene film secured with rubber bands and placed in 60 degree centigrade ($\pm$ 4 degrees centigrade) water bath for 30 minutes. Tubes were then cooled to room temperature. Contents of tubes were transferred to cuvettes for colorimetric readings using the Beckmann D. U. Spectrophotometer. Readings were completed within 20 minutes.

As the "standard" was within the limits suggested by the Sigma Technical Bulletin Number 405 (60), the sample triglyceride values were determined by the following equation:

$$\underset{\text{(milligrams per 100 milliliters serum)}}{\text{Triglyceride}} = \frac{\text{Absorbance Test}}{\text{Absorbance Standard}} \times 300.$$

Assessment of Physical Activity

Each of the subjects was interviewed by Dr. A. B. Harrison, Professor, Health, Physical Education and Recreation and Director, Oklahoma State University Physiology of Exercise Laboratory, to collect information about the subject's current pattern of physical activity. Subjects were asked to state type of activity, frequency of such activity per week and the time involved in each session. All information was recorded and from this information the average weekly aerobic points earned by each subject were calculated using Cooper's (61) aerobic points system.

Levels of activity were classified as non-exercise, and light, moderate and heavy exercise using the system shown in Table I. Each subject's activity was classified according to this system.

Physical Fitness Testing

Physical fitness testing was administered in the Oklahoma State University Physiology of Exercise Laboratory by Dr. A. B. Harrison. Each subject was administered a series of tests including the Balke Treadmill Test.

TABLE I

CLASSIFICATIONS OF LEVELS OF ACTIVITY

Level	Activity Class	Average Weekly Aerobic Points
1	Non-exercise	$\leq$ 10 points
2	Light	11 to 20 points
3	Moderate	21 to 40 points
4	Heavy	$\geq$ 41 points

For the purpose of monitoring the heart rate throughout the treadmill test, electrodes were attached to the subject. After obtaining the resting heart rate of the subject, the subject was instructed to grasp the side rails of the treadmill and to place his right foot on and off the moving belt in order to accustom the subject to the "feel" of the machine. The subject was then instructed to start walking the treadmill and when at ease to release the side rails and to continue walking in a normal walking stride. The treadmill speed remained at a constant 3.4 miles per hour. The incline of the treadmill initially at zero per cent grade was raised to two per cent after the first minute and raised one per cent each minute thereafter. The test continued with the subject continuing to walk the treadmill until the subject's heart rate reached a predetermined target rate of 180 beats per minute. Throughout the whole test, the heart rate was carefully monitored and the rate determined during the last 15 seconds of each minute. Electrocardiogram readings were taken after the subject's heart rate reached 150 beats per minute. If unusual depressions or elevations of the electrocardiogram appeared or more arrhythimas occurred in a 10 second interval, the test was terminated. At the termination, the subject was told to grasp the side rails and to step off the moving belt with the left followed by the right foot. The length of time the subject walked, the corresponding treadmill incline, and the final heart rate were all recorded.

The predicted maximal oxygen consumption in milliliters per kilogram of body weight per minute was determined from the Balke regression equation (62). This score was entered on the Cooper chart for age adjusted fitness categories (see Appendix C) to determine the subject's level of fitness.

Analysis of Data

To determine the nutrient intake status of individual subjects, percentages and mean percentages of the Recommended Dietary Allowances were computed. Frequency determinations were used for comparisons among intakes of individual subjects. In order to assess the physical activity and the physical fitness levels of the subjects, mean aerobic points and maximal oxygen consumption values were calculated. Frequency determinations were again used on comparisons. Correlation coefficients were calculated to ascertain correlations between nutrient intake and physical fitness and between physical activity and physical fitness. Analysis of variance was computed to test the relationship of levels of blood serum cholesterol and classifications of physical activity. Correlation coefficients were calculated to examine correlation between physical activity and levels of blood serum triglyceride. To correlate total dietary fat intake, saturated/unsaturated fatty acid intake ratios, and total dietary cholesterol intakes with levels of blood serum cholesterol and triglyceride correlations were computed.

CHAPTER IV

RESULTS AND DISCUSSION

The purposes of this study were to assess the nutrient intake and to identify the effect of selected nutrient intake and physical activity level on physical fitness of male volunteers from the Oklahoma State University faculty and administration. All were subjects in the ongoing Physical Fitness Research Project conducted by the Oklahoma State University Physiology of Exercise Laboratory. Of this original population, 32 were involved in this research study.

Description of the Subjects

The 32 subjects ranged in age from 31 to 62 years with a mean age of 46.2 years. Responses in regard to health condition indicated 18 subjects (56.3 per cent) in "excellent" health, 12 subjects (37.5 per cent) in "good" health, and only two subjects (6.2 per cent) in "fair" health. Disease incidence was low among the subjects as evidenced by the following: cardiovascular problems were limited to two subjects (6.2 per cent) with cases of hypertension and respiratory problems indicated for 15 subjects (46.9 per cent). The respiratory problems existed as: hayfever, 11 subjects (34.4 per cent); pneumonia, four subjects (12.5 per cent); bronchitis, two subjects (6.2 per cent); asthma, two subjects (6.2 per cent); shortness of breath, one subject (3.1 per cent); tuberculosis, one subject (3.1 per cent). There were three subjects (18.7 per cent) suffering from arthritis and three (9.4 per cent) from gout. Only one subject (3.1 per cent) indicated evidence of diabetes mellitus.

Family history of the subjects revealed that 19 (59.4 per cent) of the subjects' mothers were still living. Of the 13 deceased, five (38.4 per cent) died of cardiovascular disease, four (30.8 per cent) of cancer, and four (30.8 per cent) of unknown cause. Only 12 (37.5 per cent) fathers were still living. Of the 20 deceased, 10 (50 per cent) died of cardiovascular disease, two (10 per cent) of cancer, two (10 per cent) of emphysema, one (5 per cent) of brain tumor, one (5 per cent) of meningitis, and three (15 per cent) of unknown cause. Cardiovascular disease accounted for 32.6 per cent of the 33 deaths of parents of all subjects (see Appendix D).

Dietary information revealed that eight (25 per cent) of the 32 subjects used vitamin/mineral supplements. Of these, only one had nutrient intakes of less than two-thirds of the Recommended Dietary Allowances for any of the eight specific nutrients, and that one subject used the vitamin/mineral supplement only "sporadically".

Information concerning eating habits showed a controlled use of sugar and salt. Twenty-three subjects (71.9 per cent) either did not use sugar in their beverages or used less a teaspoon per cup. Six (18.7 per cent) used a sugar substitute. Three (9.4 per cent) used one to two teaspoons per cup and none used more than two teaspoons per cup. On cereal, 16 subjects (50.0 per cent) either did not sugar their cereal or used less than one tablespoon per bowl. Four (12.5 per cent) used a sugar substitute. Eight (25 per cent) of the subjects used one to two tablespoons and only two (6.2 per cent) used more than two tablespoons per bowl of cereal. Five (15.6 per cent) used pre-sugared cereal. Salt was either not used or sparingly used at the table by 13 subjects (40.6 per cent). Fourteen (43.8 per cent) salted foods "moderately"; five (15.6 per cent) salted foods "liberally"; none of the subjects used a salt substitute. Butter was used by eight subjects (25 per cent). Whipped margarine and regular cubed margarine were each used by 12 subjects (37.5 per cent). Four (12.5 per cent) indicated use of low calorie margarine. None of the 32 subjects indicated use of any of the egg substitute products (see Appendix E).

Nutritional Status

Generally, the nutritional intake of the 32 subjects was high. The total mean percents of the Recommended Dietary Allowances (R.D.A.) for calories and the eight selected nutrients (protein, calcium, iron, vitamin A, thiamine, riboflavin, niacin, ascorbic acid) indicated that the food intakes were at least 100 per cent of the R.D.A. except in the cases of calories and thiamine. These two nutrients were shown to have means of 86.5 per cent and 96.9 per cent respectively; and therefore, indicated levels of intake greater than two-thirds of the R.D.A.. Table II shows the mean intake and the mean per cent of the R.D.A. for calories and each of the eight nutrients according to age group.

Calorie intake was the only value that was consistently below the 100 per cent of the R.D.A. level. It was lowest (79.9 per cent) for the subjects in the 44 to 55 year age group, and highest (93.4 per cent) for the subjects in the 30 to 35 year age group. Thiamine intake was below the 100 per cent R.D.A. level in the 30 to 35 year age group (93.6 per cent), in the 46 to 55 year age group (84.6 per cent), and in the total

TABLE II

MEAN CALORIE AND NUTRIENT INTAKES AND MEAN PER CENT R.D.A.* BY AGE GROUP

Age	n	Calories		Protein		Calcium		Iron		Vitamin A		Thiamine		Riboflavin		Niacin		Ascorbic Acid	
		Intake	% RDA	Intake	% RDA	Intake	% RDA	Intake	% RDA	Intake	% RDA	Intake	% RDA	Intake	% RDA	Intake	% RDA	Intake	% RDA
30-35 years	4	2614	93.4	121.7	187.2	1198.1	149.8	15.96	159.6	4857	97.1	1.31	93.6	2.30	135.3	23.36	129.8	179	298.0
36-45 years	12	2226	85.6	96.6	148.6	1092.7	136.6	14.90	149.0	5734	114.7	1.36	104.6	1.93	113.5	18.95	111.5	122	203.3
46-55 years	11	2078	79.9	88.7	136.5	835.7	104.5	15.31	153.1	10239	204.8	1.10	84.6	1.77	104.1	18.84	110.8	152	253.3
≥ 56 years	5	2079	86.6	107.7	165.7	1082.5	135.3	16.90	169.0	6356	127.1	1.25	104.2	2.03	119.4	22.22	158.7	113	188.3
Total	32	2249	86.5	103.7	159.5	1052.2	131.5	15.77	157.7	6797	135.9	1.26	96.9	2.01	118.2	20.84	122.6	142	235.8

*R.D.A.--Recommended Dietary Allowance.

group with a mean level of 96.9 per cent of R.D.A.. Vitamin A was slightly below the 100 per cent R.D.A. in the 30 to 35 year age group with a mean of 97.1 per cent. Ascorbic acid was the nutrient with the most consistently high intake. The subjects' mean intake levels ranged from 188.3 to 298.0 per cent. As noted previously, no mean nutrient intake was below the two-thirds of the R.D.A. level.

Table III shows the classification of individual subject's calorie and nutrient intake according to the Recommended Dietary Allowances. No subject had intakes less than two-thirds of the R.D.A. for protein, iron, niacin, and ascorbic acid. For all four of these nutrients, the majority of the individuals (93.8 per cent, 90.6 per cent, 56.3 per cent and 96.9 per cent for protein, iron, niacin, and ascorbic acid, respectively) had intakes equal to or greater than 100 per cent of the R.D.A.'s. Five subjects (15.6 per cent) had caloric intakes between 51 and 67 per cent of the R.D.A.. Intakes of vitamin A showed four subjects (12.5 per cent) with intakes below two-thirds of the R.D.A.. Intakes of calcium and thiamine both showed three subjects (9.3 per cent) with intakes below the two-thirds R.D.A. level. Intakes of riboflavin were below two-thirds of the R.D.A. for two subjects (6.2 per cent). Most of the subjects had nutrient intakes equal to or greater than 100 per cent of the respective R.D.A.'s except in the case of calorie and thiamine intakes, where most intakes were between 68 and 99 per cent of the R.D.A. (Table III).

In Table IV the mean proportion of caloric intake from protein, fat, and carbohydrate according to age groups is shown. There was little difference in intake of calories from protein, fat and carbohydrate among the four age groups. The differences in mean per cent

TABLE III

CLASSIFICATION OF CALORIE AND SELECTED NUTRIENT INTAKE BY PERCENTAGE OF RECOMMENDED DIETARY ALLOWANCES
(n = 32)

Nutrient	≤ 50% RDA		51-67% RDA		68-99% RDA		≥ 100% RDA	
	n	% of 32	n	% of 32	n	% of 32	n	% of 32
Calories	-	-	5	15.6%	24	75.0%	3	9.4%
Protein	-	-	-	-	2	6.2%	30	93.8%
Calcium	2	6.2%	1	3.1%	7	21.9%	22	68.8%
Iron	-	-	-	-	3	9.4%	29	90.6%
Vitamin A	2	6.2%	2	6.2%	6	18.8%	22	68.8%
Thiamine	1	3.1%	2	6.2%	18	56.3%	11	34.4%
Riboflavin	1	3.1%	1	3.1%	9	28.1%	21	65.7%
Niacin	-	-	-	-	14	43.7%	18	56.3%
Ascorbic Acid	-	-	-	-	1	3.1%	31	96.9%

protein was found to be ± 1.98 per cent, fat was ± 1.59 per cent, and carbohydrate was ± 1.21 per cent.

TABLE IV

MEAN PROPORTION OF CALORIES FROM PROTEIN, FAT, CARBOHYDRATE BY AGE GROUPS

Age Group	n	Mean % Protein	Mean % Fat	Mean % Carbohydrate
30-35 years	4	18.03%	33.81%	48.16%
36-45 years	12	17.35%	36.78%	45.87%
46-55 years	11	17.26%	36.99%	45.75%
≥ 56 years	5	21.22%	35.02%	43.76%
Total	32	18.47%	35.65%	45.88%

Table V shows the classification of the subject's caloric intake according to percentage of calories contributed by fat intake. According to the United States Department of Agriculture estimates (63), the average share of calories provided by fat in the American diet in 1974 was 41 per cent. Calories from fat ranged from an average of 39 per cent for diets of infants to 45 per cent for men 20 to 65 years old. This level of consumption directly contrasts with the recommendation made by the Inter-Society Commission for Heart Disease Resources (64) which was that the proportion of energy derived from fat should not exceed 35 per cent of total calories from all fats and less than 10 per cent of total calories from saturated fatty acids. As seen in Table V, 22 of the 32 subjects (68.8 per cent) in this study had intakes of calories derived from fat more than the recommended level of 35 per cent.

TABLE V

CLASSIFICATION OF SUBJECTS' CALORIC INTAKE BY PERCENTAGE OF CALORIES AS CONTRIBUTED BY INTAKE OF FAT

Age Group	n	Subjects with Per Cent of Calories as Supplied by Fat Intake				
		≤ 30% n	31-35% n	36-40% n	41-45% n	≥ 46% n
30-35 years	4	1	1	1	-	1
36-45 years	12	3	1	4	2	2
46-55 years	11	1	2	7	-	1
≥ 56 years	5	1	-	3	1	-
Total	32	6	4	15	3	4

Table VI shows the classification of individual subject's fat intake by percentage of calories derived from saturated fatty acids. Seven subjects (21.9 per cent) had intakes of saturated fatty acids at the Inter-Society Commission for Heart Disease Resources (64) recommended level of 10 per cent or less of total calorie intake. Fifteen subjects (46.9 per cent) had saturated fatty acid intakes ranging from 11 to 13 per cent and five (15.6 per cent) had intakes greater than 14 per cent. The 46 to 55 year age group showed the lowest mean intake (11.47 per cent) of calories derived from saturated fatty acids.

TABLE VI

CLASSIFICATION OF SUBJECTS' FAT INTAKE BY PERCENTAGE
OF CALORIES AS SATURATED FATTY ACIDS

Age Group (Years)	n	Subjects with Per Cent of Calorie Intake as Saturated Fatty Acids ≤ 10% n	10.01-11% n	11.01-12% n	12.01-13% n	13.01-14% n	≥ 14% n	Mean Per Cent Saturated Fatty Acid
30-35	4	1	1	1	-	-	1	12.03%
36-45	12	3	-	-	5	1	3	12.67%
46-55	11	2	2	2	4	1	-	11.47%
≥ 56	5	1	-	2	1	-	1	11.64%
Total	32	7	3	5	10	2	5	12.02%

Table VII shows the classification of individual subjects according to intakes of fat as a ratio of saturated/unsaturated fatty acid content. All of the subjects consumed a higher proportion of fats of unsaturated fatty acid content than fats of saturated fatty acid content. Seventeen subjects (53.1 per cent) consumed a ratio of saturated/unsaturated fatty acids of 1:3 to 1:2, 10 subjects (31.3 per cent) consumed a ratio of 1:2 to 2:3. In total, 27 subjects (84.4 per cent) consumed a ratio of 1:3 to 2:3 saturated/unsaturated fatty acids.

TABLE VII

CLASSIFICATION OF INDIVIDUAL SUBJECTS ACCORDING TO INTAKE OF FAT AS A RATIO OF SATURATED/UNSATURATED FATTY ACID CONTENT

		Subjects with Saturated to Unsaturated Fatty Acid Ratio (S/U)*					
		≤ 1:4	1:4–1:3	1:3–1:2	1:2–2:3	2:3–3:4	≥ 3:4
Age Group	n	n	n	n	n	n	n
30–35 years	4	–	–	2	1	1	–
36–45 years	12	–	–	4	6	2	–
46–55 years	11	–	1	7	3	–	–
≥ 56 years	5	–	–	4	–	1	–
Total	32	0	1	17	10	4	0

*Unsaturated fatty acid intake, calculated by subtraction of saturated fatty acids from total dietary fats, includes both mono and polyunsaturated fatty acids.

Table VIII shows the mean, minimum, and maximum intake values of cholesterol according to age groups. The average American diet contains more than 600 milligrams of cholesterol per day according to the Inter-Society Commission for Heart Disease Resources (64) which recommends a reduction of total dietary intake of cholesterol to less than 300 milligrams per day. Of the 32 subjects in the study, 13 (40.6 per cent) had cholesterol intakes at the recommended level of 300 milligrams per day or less, leaving 19 (59.4 per cent) with cholesterol intakes greater than the recommended level. Only four subjects (15.6 per cent) had cholesterol intakes of greater than 500 milligrams per day.

TABLE VIII

CHOLESTEROL INTAKE ACCORDING TO AGE GROUPS

		Cholesterol Intake (Milligrams)			
Age Group	n	Mean	Minimum	Maximum	Difference
30-35 years	4	506	162	1149	987
36-45 years	12	322	159	643	484
46-55 years	11	346	146	850	704
$\geq$ 56 years	5	397	206	517	311

Assessment of Physical Activity

Aerobic points earned individually by the 32 subjects ranged from 0 to 480 points with a mean score of 36.88 per week. According to the activity classification (see Appendix F) this indicates a mean level of moderate activity. Only two subjects (6.2 per cent) indicated earning zero aerobic points per week.

Table IX shows the mean aerobic points per week and the mean activity class according to age group. The 30 to 35 year age group had the highest aerobic points mean and the second from the lowest activity class mean. One subject in this age group averaged 480 aerobic points per week while the remaining three subjects averaged from zero to eight aerobic points per week. This caused the high aerobic points mean in contrast with the low activity class mean. The 46 to 55 year age group with a mean aerobic points of 29.55 per week and a mean activity class of 2.91 had the highest pattern of physical activity. The over 55 year age group demonstrated the lowest level of physical activity with mean aerobic points per week of 13.80 and mean activity class of 1.60.

TABLE IX

MEAN AEROBIC POINTS PER WEEK AND MEAN ACTIVITY CLASS ACCORDING TO AGE GROUP

		Physical Activity	
Age Group	n	Mean Aerobic Points per Week	Mean Activity Class
30-35 years	4	123.75	1.75
36-45 years	12	24.25	2.33
46-55 years	11	29.55	2.91
$\geq$ 56 years	5	13.80	1.60
Total	32	36.88	2.31

Table X shows the classification of subjects' physical activity class (see Appendix F) according to age groups. Ten subjects (31.3 per cent) engaged in physical activity at the "moderate exercise" level, and eight subjects (25.0 per cent) at the "light exercise" level. Nine subjects (28.1 per cent) had physical activity at the "non-exercise" level in contrast with the five subjects (15.6 per cent) at the "heavy exercise" level. Eighteen subjects (56.3 per cent) engaged in physical activity at the "light" to "moderate" activity levels.

TABLE X

CLASSIFICATION OF SUBJECTS' ACTIVITY CLASS ACCORDING TO AGE GROUPS

Age Group	n	Physical Activity Classes* 1	2	3	4	Mean Activity Class
30-35 years	4	3	-	-	1	1.75
36-45 years	12	3	4	3	2	2.33
46-55 years	11	1	1	7	2	2.91
$\geq$ 56 years	5	2	3	-	-	1.60
Total	32	9	8	10	5	2.34

*See Appendix F for physical activity classification.

Determination of Physical Fitness

Generally, physical fitness of the 32 subjects ranged from "good" to "excellent". Only four subjects (12.5 per cent) had physical fitness levels in the "fair" category. Maximal oxygen consumption (VO_2 Max) ranged from 32 to 63 milliliters of oxygen per kilogram of body weight per minute (ml./kg./min.) with a mean of 43.22 ml./kg./min.. The mean physical fitness class (see Appendix C) was 4.22, or "good". Table XI shows the mean maximal oxygen consumption and the mean physical fitness category according to age group.

TABLE XI

MEAN MAXIMAL OXYGEN CONSUMPTION (VO_2 MAX) AND MEAN FITNESS CATEGORY BY AGE GROUP

Age Group	n	Mean VO_2 Max (ml./kg./min.)	Mean Fitness Category*
30-35 years	4	47.75	4.25
36-45 years	12	42.33	3.92
46-55 years	11	45.18	4.73
$\geq$ 56 years	5	37.40	3.80
Total	32	43.22	4.22

*See Appendix C for physical fitness classifications.

The 30 to 35 year age group had the highest mean VO_2 Max and the second highest mean fitness class. As was the case in the physical activity classification, the elevated mean VO_2 Max was due to one subject in the age group who had a VO_2 Max of 63 ml./kg./min.. By omitting this subject, the 30 to 35 year age group would have had a mean VO_2 Max of 42.67 ml./kg./min. and a mean fitness category of 4.00. Subjects within the 46 to 55 year age group had the most consistently high level of maximal oxygen consumption and the highest physical fitness category with a mean VO_2 Max of 45.18 ml./kg./min. and a mean physical fitness category of 4.73. The subjects in the over 55 year age group demonstrated the lowest level of physical fitness with a mean VO_2 Max of 37.40 ml./kg./min. and a mean physical fitness category of 3.80.

Table XII shows the classification of physical fitness categories of subjects according to age. Eleven subjects (34.4 per cent) were classified in the "excellent" category of physical fitness; 17 subjects (53.1 per cent) in the "good" category; four subjects (12.5 per cent) in the "fair" category; and no subjects in either the "poor" or "very poor" categories.

TABLE XII

CLASSIFICATION OF PHYSICAL FITNESS CATEGORIES
OF SUBJECTS BY AGE GROUPS

Age Group	n	Physical Fitness Category				
		1. Very Poor	2. Poor	3. Fair	4. Good	5. Excellent
30-35 years	4	-	-	-	3	1
36-45 years	12	-	-	3	7	2
46-55 years	11	-	-	-	3	8
$\geq$ 56 years	5	-	-	1	4	-
Total	32	0	0	4	17	11

The 46 to 55 year age group had the highest number of subjects in the "excellent" category. Within the 46 to 55 year age group, eight subjects (72.7 per cent of that group) were in the "excellent" category and the remaining three subjects (27.3 per cent) were in the "good" category. The 36 to 45 year age group had two subjects (16.7 per cent of that group) in the "excellent" category. This was offset by the three subjects (25 per cent of the group) in the "fair" physical fitness category. The remaining seven subjects (58.3 per cent of the group) were in the "good" category. The over 55 year age group had, as a group, the lowest level of physical fitness with one subject (20 per cent of the group) in the "fair" category and the remaining four subjects (80 per cent of the group) in the "good" category.

Correlation of Selected Nutrient Intake and Physical Fitness

No significant correlation was found between physical fitness and calories or any of the nutrients selected for this study. These included:

1. calories,
2. per cent of the calorie R.D.A.,
3. protein,
4. per cent of the protein R.D.A.,
5. total fat,
6. per cent of total calories as fat,
7. saturated fat,
8. saturated/unsaturated fatty acid ratio, and
9. cholesterol.

See Appendix G for correlation coefficients.

Correlation of Physical Activity and Physical Fitness

Through statistical analysis, it was found that the level of physical activity in terms of aerobic points was correlated positively to physical fitness in terms of maximal oxygen consumption. That is, as a subject's physical activity increased in frequency and/or duration, the subject's maximal oxygen consumption capacity also increased. The correlation coefficient was 0.504618 and was found to be significant at the $< .01$ level. When the activity classifications were correlated with the physical fitness classifications the two were positively correlated with a correlation coefficient of 0.450080. This was significant at the $< .01$ level (see Appendix G).

Correlation of Age and Physical Fitness

Age was found to be negatively correlated with physical fitness in terms of maximal oxygen consumption with a correlation coefficient of -0.369310. This was significant at the $< .05$ level (see Appendix G).

Correlation of Selected Nutrient Intakes to Serum Cholesterol and Triglyceride Levels

The level of total serum cholesterol was found to be negatively correlated with saturated/unsaturated fatty acid intake ratio. The correlation coefficient was -0.394988 which was significant at the $< .05$ level. No significant correlation of total serum cholesterol levels with total dietary intake of fat and dietary intake of cholesterol was found.

The level of serum triglycerides was found not to be significantly correlated at the $< .05$ level with any of the following: total dietary fat intake, saturated/unsaturated fatty acid content, and dietary intake of cholesterol. See Appendix G for correlation coefficients.

Relationship of Physical Activity to Serum Cholesterol Levels

The F value obtained from the analysis of variance on classifications of physical activity and levels of serum cholesterol was 4.5526 and evidenced a negative relationship significant at the .05 level. This demonstrated that as physical activity increased the individual subject's level of total serum cholesterol decreased (see Appendix G).

Correlation of Physical Activity and Serum Triglyceride Levels

No significant correlation was determined for serum triglyceride levels with physical activity in terms of classification levels or in terms of aerobic points. See Appendix G for correlation coefficient values.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The lengthened human life span has created not only more physical, psychological, sociological, and economic issues, but also the problems of maintaining health and efficiency during added years. Aging is a natural wearing-out process which affects all things living and non-living. This process may be accelerated by abuse or decelerated by care. More research is needed to discover the relationship between improvement of nutritional status and increased physical activity to maintenance of productivity.

The research presented in this thesis focused on the objectives to assess the current nutrient intake and to identify the effect of specific nutrient intakes and physical activity levels on physical fitness. The specific objectives were:

1. to determine the nutrient intake of each subject in the study;
2. to correlate selected nutrient intakes including total calorie intake, total dietary fat intake, saturated/unsaturated fatty acid intake ratio, and total dietary cholesterol intake with physical fitness level as indicated by maximal oxygen consumption for each subject;
3. to correlate physical activity in terms of average aerobic points earned per week with physical fitness as indicated by maximal oxygen consumption for each subject;

4. to correlate total dietary fat intake, saturated/unsaturated fatty acid intake ratio, and total dietary cholesterol intake with blood levels of serum cholesterol and triglyceride of each subject;
5. to determine the relationship of levels of physical activity with levels of blood serum cholesterol for each subject;
6. to correlate level of physical activity with level of blood serum triglyceride for each subject.

Summary

The population of the study was defined as the male volunteers from the Oklahoma State University faculty and administration who were subjects in the ongoing Physical Fitness Research Project conducted by the Oklahoma State University Physiology of Exercise Laboratory. Thirty-two subjects completed both the dietary intake records and the physical fitness testing during June, July and August, 1977, and were included as the final sample in this study.

Nutrient intake data was acquired through questionnaires, four-day food intake records and personal interviews and was processed by computer methods. Calories and the following nutrients were selected for assessment: protein, calcium, iron, vitamin A, thiamine, riboflavin, niacin, ascorbic acid, total fat, saturated fat, and cholesterol. Nutrient intake reliability was ascertained by comparison with 24-hour recall data.

Fasting blood samples were analyzed for total serum cholesterol according to the method established by Bloor (58) (59) and for serum triglyceride using the method outlined in the Sigma Technical Bulletin Number 405 (60).

Oklahoma State University Physical Fitness Research Project data assessing each subject's physical activity in terms of average aerobic points earned per week and each subject's physical fitness in terms of maximal oxygen consumption was obtained. Percentages, mean percentages, and frequency determinations were used to assess the nutrient intake status, the physical activity status, and the physical fitness level of each subject. Correlation coefficients were calculated to ascertain relationships between nutrient intake and physical fitness, physical activity and physical fitness, and physical activity and levels of blood serum triglyceride. Correlation coefficients were also used to correlate selected nutrient intakes with levels of blood serum cholesterol and triglyceride. Analysis of variance was computed to test the relationship of levels of blood serum cholesterol and classifications of physical activity.

The 32 subjects ranged in age from 31 to 62 years with a mean age of 46.2 years. Health condition was listed as "excellent" for 56.3 per cent of the subjects; as "good" for 37.5 per cent; and "fair" for only 6.2 per cent. None listed their health as "poor". Family data indicated that 67.2 per cent of the subjects' parents were deceased of whom 32.6 per cent died of cardiovascular disease.

The food record analysis indicated a consistently high nutrient intake among all subjects. The total sample mean percentage of the R.D.A.'s for calories and the eight selected nutrients were greater than or equal to 100 per cent except for calories and thiamine with mean intakes of 86.5 per cent and 96.9 per cent. Calorie intake means ranged from 79.9 per cent of the R.D.A. in the 46 to 55 year age group to 93.4 per cent in the 30 to 35 year age group. Thiamine intake means ranged from 86.6 per cent of the R.D.A. in the 46 to 55 year age group to 93.6 per cent in the 30 to 35 year age group. Vitamin A intake was slightly below 100 per cent of the R.D.A. with a mean of 97.1 per cent in the 30 to 35 year age group. Ascorbic acid intake was high among all age groups with mean percentages of the R.D.A. ranging from 100.3 per cent to 298.0 per cent.

Most subjects had nutrient intakes greater than or equal to 100 per cent of the R.D.A.'s except for calories and thiamine where most intakes ranged from 68 to 99 per cent of the R.D.A.'s. Intakes of calcium and thiamine were less than two-thirds of the R.D.A.'s for 9.3 per cent of the subjects. Intakes of riboflavin were less than two-thids of the R.D.A. for 6.2 per cent of the subjects.

The mean intake of calories from total dietary fat was 35.65 per cent. Individually intakes were less than 35 per cent for 31.3 per cent and between 36 and 40 per cent for 46.9 per cent of calories derived from saturated fatty acids; 21.9 per cent had intakes less than 10 per cent of total calorie intake; 46.9 per cent had intakes between 11 and 13 per cent. The 46 to 55 year age group had the lowest mean intake of calories derived from saturated fatty acids.

Cholesterol intakes were low with 40.6 per cent of the subjects with intakes less than 300 milligrams. Only 15.6 per cent had cholesterol intakes greater than 500 milligrams per day.

Physical activity levels ranged from "non-exercise" to "heavy exercise" categories. The sample mean aerobic points per week was 36.88 indicating a mean level of "moderate" activity. The 46 to 55 year age group showed the most consistently high level of physical activity with mean aerobic points per week of 29.55 and a mean activity class of 2.91. The least physically active group was the over 55 year age group which had a mean aerobic points value of 13.80 and a mean activity class value of 1.60. "Heavy exercise" classification was indicated for 15.6 per cent of the total sample, "moderate exercise" for 31.6 per cent, "light exercise" for 25.0 per cent, and "non-exercise" for 28.1 per cent. More than one-half of the subjects indicated physical activity level in the light to moderate classification.

Generally, physical fitness ranged from "good" to excellent" with only 12.5 per cent in the "fair" category. Maximal oxygen consumption ranged from 32 to 63 ml./kg./min. with a mean value of 43.22 ml./kg./min. The mean physical fitness classification was 4.22 indicating the "good" category. The 46 to 55 year age group had the highest level of physical fitness; the over 55 year age group had the lowest level. Individually, 34.4 per cent of the subjects tested in the "excellent" category of physical fitness, 53.1 per cent in the "good" category, 12.5 per cent in the "fair", and none in the "poor" or "very poor" categories.

No significant correlation was found between physical fitness and calories or any of the nutrient intakes selected for the study. These included protein, per cent of protein R.D.A., total fat intake, per cent of total calories from fat intake, saturated fat intake, saturated/unsaturated fatty acid intake, and cholesterol intake.

The level of physical activity in terms of aerobic points was correlated positively with physical fitness in terms of maximal oxygen consumption. The correlation coefficient was 0.504618 which was significant at the < .01 level.

Age was negatively correlated with physical fitness. The correlation coefficient was -0.369310 which was significant at the < .05 level.

Level of serum cholesterol was found to be negatively correlated with saturated/unsaturated fatty acid intake ratio. The correlation coefficient was -0.394988 and was significant at the < .05 level.

No significant correlation was found between serum cholesterol or triglyceride levels and total dietary fat intake, saturated/unsaturated fatty acid intake ratio, or total dietary cholesterol intake.

Analysis of variance of classes of physical activity and levels of serum cholesterol yielded an F value of 4.5526 indicating a negative relationship significant at the .05 level. No significant relationship was determined for serum triglyceride levels with level of physical activity.

Conclusions

In summary, the results of this study demonstrated the following:

1. Physical fitness in terms of maximal oxygen consumption varied among individual subjects. The 46 to 55 year age group had the highest level of maximal oxygen consumption with a mean of 45.18 ml./kg./min.; the over 55 year age group had the lowest with a mean of 37.40 ml./kg./min..
2. Physical activity levels in terms of aerobic points varied from 0 to 480 points among individual subjects. The 46 to 55 year age group showed the most consistently high level of physical activity with mean aerobic points of 29.55; the over 55 year

age group had the lowest level of physical activity with mean aerobic points of 13.80.

3. Nutritional intake was consistently high among subjects; 84.4 per cent of the subjects had intakes of all eight nutrients greater than two-thirds of the R.D.A. for each nutrient and 18.7 per cent had intakes greater than 100 per cent of the R.D.A..
4. As age increased, physical fitness in terms of maximal oxygen consumption decreased significantly.
5. As physical activity increased in duration and frequency, as evidenced by increases in aerobic points, physical fitness increased significantly.
6. No correlation of the level of nutrient intake with physical fitness was found.

From these results, it seemed reasonable to identify the following two conclusions:

1. That physical fitness in terms of maximal oxygen consumption is related to age, level of physical activity, and level of nutrient intake. Because nutritional intake was high in subjects of both high and low physical fitness levels, correlation of the level of nutrient intake with level of physical fitness for the individual subject was masked.
2. That, if nutritional intake status is high, the negative effects of aging can be somewhat overcome with increased levels of physical activity. This effect was seen in the 46 to 55 year age group. This group showed higher levels of physical activity and also higher levels of physical fitness than the

two younger groups. All three groups had high levels of nutritional intake.

Recommendations

Recommendations for further study include:

1. Further research to determine seasonal variations in nutrient intake of the particular population studied in this research project.
2. Further research concerning the nutrient intake and effect of selected nutrient intake and physical activity on physical fitness of random samples of middle-aged and elderly men and women.
3. Research concerning the effect of diet control and physical activity on physical fitness of random samples of adults.
4. Investigation of a possible relationship of serum concentrations of high density lipoproteins to levels of dietary fat intake, physical activity and physical fitness.

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APPENDIXES

APPENDIX A

SAMPLE INFORMATION PACKET

Oklahoma State University

Department of Food, Nutrition and Institution Administration

STILLWATER, OKLAHOMA 74074
(405) 624-5038

June 22, 1977

Dear Sir:

The O.S.U. Department of Food, Nutrition, and Institution Administration in cooperation with the O.S.U. Physiology of Exercise Laboratory is conducting a research project which is attempting to demonstrate the relationship of physical fitness and nutritional status. As a subject in the ongoing Physical Fitness research project conducted by Dr. A. B. Harrison, you have been identified as a person interested in health and physical fitness. We would like to ask you to participate in this research project.

In order to be able to evaluate your current nutritional and health status we ask you to do the following:

a. complete the enclosed questionnaire,
b. keep two two-day food intake records,
c. have a venous blood sample drawn for lipid analysis.

Instructions for the questionnaire and the food intake records are attached to the respective forms. All are enclosed in this packet. If possible, would you please complete the questionnaire and the first two-day food intake record (FORM A) and return them by campus mail in the enclosed self-addressed envelope by July 8. The second two-day food intake record (FORM B) should be put into the campus mail in the remaining envelope by July 15.

The blood lipid analysis is an optional part of this research. However, we strongly urge you to take this opportunity to have your serum cholesterol and triglyceride levels determined. Blood samples will be drawn at O.S.U. Student Health Center between 8:00 and 11:00 a.m. Monday, July 11 through Friday, July 15. The sample must be a 12-hour fasting sample. Therefore, do <u>not</u> eat breakfast the morning you are to have the sample drawn. Clinic appointments are not taken. Just report to the front reception desk during the designated hours during the week of July 11-15. Bring with you the signed CONSENT FORM (found in this packet) to identify you as a participant in this project.

The findings of this research project will be reported in a thesis with no mention of the names of the subjects involved. Individual nutritional assessment and blood analysis results will become a part of each subject's personal data folder on file in the Physiology of Exercise Laboratory. All personal information will be held strictly confidential.

If you would like a brief summary of the findings of this research, a copy of your individual nutritional assessment, or a copy of your individual blood analysis results, we shall be happy to send it to you. Please indicate the information desired on the appropriate line on the DATA REQUEST form. The results will be available in September.

We appreciate your participation in this research. It is only through the contributions of persons such as you that we can gain greater understanding of the phenomenon of health.

Yours very truly,

Rebecca A. Reeder

Rebecca Bogert Reeder
Graduate Student
F.N.I.A. Department

Esther Winterfeldt

Esther Winterfeldt, Ph. D.
Professor and Head
F.N.I.A. Department

Oklahoma State University

School of Health, Physical Education and Leisure Services

STILLWATER, OKLAHOMA, 74074
COLVIN PHYSICAL EDUCATION CENTER
(405) 624-5493

June 23, 1977

To: Participants in the Faculty Fitness Research Program

From: A. B. Harrison

I have been working with Ms. Rebecca Reeder, a graduate student in Foods and Nutrition, for the past several weeks in planning the research study described in this packet. The subjects will be those OSU male faculty members who have been evaluated in our laboratory. She will be using fitness scores and exercise habits to relate to the dietary information and the blood lipid data obtained. The data will be used for her Master's thesis but will also be made available for your record file in our laboratory. I consider the dietary and blood lipid data to be most valuable information to add to your records. I strongly recommend that if at all possible you participate in this research study.

QUESTIONNAIRE

Your participation in this research is greatly appreciated. Your contribution to a research project of this type helps us gain greater knowledge into the relationship of diet and physical activity to the maintenance of health.

The purpose of the following questions is to determine your general health status and to assess some of your dietary habits. Please answer as accurately as possible and not according to how you think you "ought" to answer.

Please check or fill in answers appropriate to each question. You are free to omit any question you do not want to answer. All of the information will be kept strictly confidential. The findings will be reported in a thesis with no mention of the name of any research subject.

Thank you for your cooperation.

1. Name: ______________________________

2. Age: ______________________________

3. Do (did) you have any of the cardiovascular problems listed below?

	Yes	No	Do Not Know
a. arteriosclerosis	____	____	____
b. hypertension	____	____	____
c. ventricular extrasystole	____	____	____
d. ventricular hypertrophy	____	____	____
e. angina pectoris	____	____	____
f. coronary infarct	____	____	____
g. heart surgery	____	____	____

4. If your answer was "yes" to any part of question 3, please state briefly:

   a. Date of diagnosis: ______________________________

   b. Medication and treatment: ______________________________

   c. Date of surgery: ______________________________

   d. Other pertinent information: ______________________________

5. Do (did) you have any of the respiratory problems listed below?

	Yes	No	Do Not Know
a. shortness of breath	____	____	____
b. hay fever	____	____	____
c. bronchitis	____	____	____
d. chronic bronchitis	____	____	____
e. bronchial asthma	____	____	____
f. emphysema	____	____	____
g. pneumonia	____	____	____
h. tuberculosis	____	____	____
i. lung surgery	____	____	____

6. Do (did) you have any of the following joint inflammation problems?

	Yes	No	Do Not Know
a. arthritis	____	____	____
b. gout	____	____	____

7. Are you diabetic? Yes ____ No ____

8. Are you on medication for any reason? Yes ____ No ____

9. If you are on medication, please name below.

a. ______________________________ ____ times per day

b. ______________________________ ____ times per day

c. ______________________________ ____ times per day

10. How would you classify your general health?

a. excellent ____

b. good ____

c. fair ____

d. poor ____

11. How long did your parents live? If still living, please indicate.

    a. mother ________________

    b. father ________________

12. If known, please state the cause of death.

    a. mother ________________

    b. father ________________

13. Do you take vitamin/mineral supplements? Yes ____ No ____

14. Please list the vitamins and minerals as stated on the label.

    Vitamin/mineral__________________________ Amount ______________

    Vitamin/mineral__________________________ Amount ______________

    Vitamin/mineral__________________________ Amount ______________

15. Do you take an iron supplement (e.g., "Geritol")? Yes ____ No ____

    Please specify ____

16. Do you use sugar in your coffee and tea? Yes ____ No ____

17. If you do, please indicate the amount used.

    a. less than a teaspoon ____

    b. 1 to 2 teaspoons ____

    c. more than 2 teaspoons ____

    d. I use sugar substitute ____

18. How much sugar do you use on a bowl of breakfast cereal?

    a. I eat pre-sugared cereal ____

    b. less than a tablespoon ____

    c. 1 to 2 tablespoons ____

    d. more than 2 tablespoons ____

    e. I use a sugar substitute ____

19. How do you salt your food before eating?

    a. I do not salt ____

    b. sparingly ____

    c. moderately ____

    d. liberally ____

    e. I use salt substitute ____ Please specify ____________________

20. Of the following, which do you use?

    a. whipped margarine ____

    b. low calorie margarine ____

    c. regular cubed margarine ____

    d. butter ____

21. If you use a margarine, please specify the brand of the one usually used. ______________________________

22. Do you use an egg substitute (e.g., "Egg Beaters")? Yes ___ No __

FOOD INTAKE RECORD INSTRUCTIONS

To make a reliable assessment of your average nutrient intake, it is necessary to obtain more than one two-day food intake record. Please use FORM A to record your food intake for any two consecutive days (Monday through Friday ONLY). Use FORM B to record your food intake for a second period of two consecutive days (Monday through Friday ONLY). For example, you may choose to keep your record of food intake on Monday and Tuesday, June 27 and June 28, respectively, and again on the following Tuesday and Wednesday, July 5 and 6. Do not use Monday, July 4.

It is important that all food eaten at ANY time during the two-day periods be recorded as to the name and the amount of the food. Therefore, a late evening snack of Hideaway pizza and a Dr. Pepper would be recorded as:

Example:

Time	Food	Amount	Ingredients
10:00 p.m.	sausage pizza Dr. Pepper	two 3" sectors one 12 oz. can	sausage, cheese

Estimate as accurately as possible the amount eaten. A serving of peas for dinner would be recorded as "one-half cup canned peas". Slices of fresh tomato would be recorded as "one medium tomato, sliced".

Combination dishes must be listed with the major ingredients in order to be able to assess their nutrient content. For example, dinner dishes of gelatin salad and tuna casserole would be recorded as follows:

Example:

Time	Food	Amount	Ingredients
5:30 p.m.	gelatin salad	1/3 cup (or 2"x3"x2" pc.)	strawberry gelatin strawberries, fresh sour cream
	tuna casserole	3/4 cup	tuna cream of mushroom soup peas and carrots, frozen cheddar cheese, grated

Your FOOD INTAKE RECORD should include a listing of ALL foods consumed. All beverages are to be included in this intake.

Thank you for your cooperation and consideration in this project.

FORM A

FOOD INTAKE RECORD--DAY 1

FOR OFFICE USE ONLY
(LEAVE BLANK)

CODE	MULTIPLE	TIME	FOOD	AMOUNT	INGREDIENTS

CONSENT FORM

Subject's Name: ________________________________ Date: ________________

I hereby authorize the Oklahoma State University Health Center laboratory technician to draw a 10 ml sample of venous blood. I understand that this sample is to be used in a research project and will be analyzed for serum cholesterol and triglyceride levels.

I understand that all test results will be kept confidential and will become a part of my personal data folder on file in the Physiology of Exercise Laboratory. Test results will not be released to anyone without my written permission. Tabulated results will be used as group data and in no case will a subject's personal identity be associated with his test results.

Subject's Signature: _______________________

DATA REQUEST

Subject's Name: ________________________________

Address: ________________________________

____

I would like to recieve a copy of the following information:

a. a brief summary of the results of this research ____

b. a summary of my nutritional assessment ____

c. a copy of the results of my blood analysis ____

Oklahoma State University

Department of Food, Nutrition and Institution Administration

STILLWATER, OKLAHOMA 74074
(405) 624-5038

July 12, 1977

Dear Sir:

Thank you for your support in the O.S.U. F.N.I.A. Department and Physiology of Exercise Laboratory cooperative research project. The questionnaires and the first two-day food intake records have been received from a number of you. If you should be behind in keeping your food intake records, as has been indicated by a few of you, just start today. Put your name on the completed forms and mail as soon as they are ready. All forms should be mailed before July 22.

For those of you who are on schedule, this week is the week that the second two-day food intake records are to be kept and mailed.

Blood samples are being taken at the O.S.U. Health Center between 8:00 and 11:00 a.m. this week. These samples are 12-hour fasting samples; so, do not eat breakfast the morning you plan to have your blood drawn. No appointment is necessary. Just report to the front reception desk at a convenient morning hour.

Again, thank you for your help and consideration in this project.

Yours very truly,

Becky Reeder

Rebecca Bogert Reeder
Graduate Student
F.N.I.A. Department

APPENDIX B

CHEMICAL REAGENTS USED FOR BLOOD LIPID DETERMINATIONS

A. Chemical Reagents Used for the Serum Cholesterol Determination

1. Alcohol-Ether Mixture
   Mixture of three volumes of absolute ethyl alcohol (U.S.P.) and one volume anhydrous peroxide free ether (A.C.S.)
2. Chloroform, Anhydrous (A.C.S.)
3. Acetic Anhydride (A.C.S.)
4. Sulfuric Acid, Concentrated (A.C.S.)

B. Chemical Reagents Used for the Serum Triglyceride Determination

1. Triglyceride Purifier
   Activated Alumina
   Sigma Stock Number 405-3, bulk
2. Isopropyl Alcohol, Anhydrous
   Sigma Stock Number 405-7
3. Triolein Standard
   Solution of 300 milligrams triolein (glycerol troleate) dissolved in 100 milliliters anhydrous isopropul alcohol
   Sigma Stock Number 405-10
4. Potassium Hydroxide Solution, _1_ Normal
   Sigma Stock Number 405-1
5. Periodate Solution
   Mixture of 125 milligrams sodium m-periodate and 50 milliliters acetic acid solution, _2_ Normal
   Sigma Stock Number 405-9 and Sigma Stock Number 405-12
6. Color Reagent
   Mixture of the following aged overnight in an amber bottle at five degrees centigrade:
   - 20 milliliters ammonium acetate solution, _2_ Molar
     Sigma Stock Number 405-2
   - 40 milliliters isopropyl alcohol, anhydrous
     Sigma Stock Number 405-7
   - 0.15 milliliters acetylacetone
     Sigma Stock Number 405-4

APPENDIX C

CLASSIFICATIONS OF PHYSICAL FITNESS

TABLE XIII

AGE ADJUSTED MAXIMAL OXYGEN CONSUMPTION CATEGORIES

Fitness Category	Oxygen Consumption (ml./kg./min.)			
	< 30 Years	30-39 Years	40-49 Years	≥ 50 Years
1. Very Poor	< 25.0	< 25.0	< 25.0	
2. Poor	25.0-33.7	25.0-30.1	25.0-26.4	< 25.0
3. Fair	33.8-42.5	30.2-39.1	26.5-35.4	25.0-33.7
4. Good	42.6-51.5	39.2-48.0	35.5-45.0	33.8-43.0
5. Excellent	≥ 51.6	≥ 48.1	≥ 45.1	≥ 43.1

Source: K. H. Cooper, The New Aerobics (New York, 1970), p. 28.

APPENDIX D

CAUSES OF DEATH OF PARENTS OF

INDIVIDUAL SUBJECTS

TABLE XIV

NUMBER AND CAUSE OF DEATH OF SUBJECTS' PARENTS BY AGE

Age (years)	Number	Cause of Death: Cardiovascular Disease	Cancer	Emphysema	Brain Tumor	Menningitis	Old Age	Unknown
A. For Mothers:								
< 40								
41-50								
51-60	2	1	1					
61-70	3	1	2					
71-80	3	1	1					1
> 81	5	1					1	3
Total	13	4	4				1	4
B. For Fathers:								
< 40								
41-50	1	1						
51-60	3	3	1					
61-70	8	3	1	1	1	1		
71-80	5	3		1			1	
> 81	3							3
Total	20	10	2	2	1	1	1	3
Total A & B	33	14	6	2	1	1	2	7

APPENDIX E

USE OF SUGAR AND SALT BY INDIVIDUAL SUBJECTS

TABLE XV

USAGE OF SUGAR AND SALT BY SUBJECTS*

Sugar in Coffee/Tea		Sugar on Breakfast Cereal		Salt on Foods	
Amount	Number	Amount	Number	Amount	Number
None	17	None	8**	Do not add salt	6
< 1 tsp.	6	Pre-sugared cereal	5**	Sparingly	7
1-2 tsp.	3	< 1 tablespoon	8	Moderately	14
> 2 tsp.	0	1-2 tablespoons	8	Liberally	5
Sugar substitute	6	> 2 tablespoons	2	Salt substitute	0
		Sugar substitute	4		

*n = 32.

**Some subjects answered more than one blank.

APPENDIX F

CLASSIFICATIONS OF PHYSICAL ACTIVITY

TABLE XVI

CLASSIFICATION OF LEVELS OF PHYSICAL ACTIVITY

Level	Activity Class	Aerobic Points
1	Non-exercise	$\leq$ 10 points
2	Light	11 to 20 points
3	Moderate	21 to 40 points
4	Heavy	$\geq$ 41 points

APPENDIX G

CORRELATION COEFFICIENTS FOR SELECTED VARIABLES

TABLE XVII

MATRIX OF CORRELATION COEFFICIENTS AS COMPUTED
FOR SELECTED VARIABLES
(n = 32)

	Age	Calories Total	Calories % RDA	Protein Total	Protein % RDA
Age	1.000000	-0.286527	-0.931040	-0.148925	-0.148696
	0.0000	0.1082	0.6180	0.5790	0.5182
Calories:					
Total	-2.865270	1.000000	0.969483	0.667223	0.667024
	0.1082	0.0000	0.0001	0.0001	0.0001
% RDA	-0.093104	0.969483	1.000000	0.619736	0.619528
	0.6180	0.0001	0.0000	0.0003	0.0003
Protein:					
Total	-0.148925	0.667223	0.619736	1.000000	0.999999
	0.5790	0.0001	0.0003	0.0000	0.0000
% RDA	-0.148696	0.667024	0.619528	0.999999	1.000000
	0.5782	0.0001	0.0003	0.0000	0.0000
Fat:					
Total	-0.077836	0.491916	0.503715	0.309837	0.309700
	0.6753	0.0044	0.0036	0.0810	0.0811
% RDA	0.090139	-0.201060	-0.182981	-0.135615	-0.135621
	0.6291	0.2692	0.3172	0.5344	0.5344
Saturated	-0.157659	0.578233	0.585910	0.354213	0.354023
	0.6072	0.0008	0.0007	0.0442	0.0443
S/U	-0.241425	0.428512	0.426123	0.175855	0.175616
	0.1802	0.0138	0.0143	0.6628	0.6621
Cholesterol	0.034273	0.278742	0.260383	0.369884	0.370187
	0.8464	0.1188	0.1466	0.0351	0.0349
Serum Cholesterol	0.275710	0.132671	0.155406	0.369846	0.370036
	0.1698	0.5249	0.5456	0.0600	0.0599
Serum Triglyceride	-0.072540	-0.375605	-0.405198	-0.237242	-0.237537
	0.7195	0.0508	0.0340	0.2317	0.2311
Activity:					
Aerobic	-0.288138	0.552112	0.487117	0.498547	0.498459
Pts.	0.1062	0.0014	0.0049	0.0039	0.0039
Class	0.072755	0.149971	0.191262	-0.085453	-0.085286
	0.6944	0.5824	0.2946	0.6466	0.6473
Physical Fitness:					
VO_2 Max	-0.369310	0.260495	0.139812	0.240111	0.240263
	0.0354	0.1464	0.5486	0.1827	0.1824
Class	0.030138	-0.032665	-0.056333	-0.178343	-0.177641
	0.8642	0.8533	0.7572	0.6701	0.6681

TABLE XVII (Continued)

	Fat				
	Total	% RDA	Saturated	S/U	Choles.
Age	-0.077836	0.090139	-0.157659	-0.241425	0.034273
	0.6753	0.6291	0.6072	0.1802	0.8464
Calories:					
Total	0.491916	-0.201060	0.578233	0.428512	0.278742
	0.0044	0.2692	0.0008	0.0138	0.1188
% RDA	0.503715	-0.182981	0.585910	0.426123	0.260387
	0.0036	0.3172	0.0007	0.0143	0.1466
Protein:					
Total	0.309837	-0.135615	0.354213	0.175855	0.369884
	0.0810	0.5344	0.0442	0.6628	0.0351
% RDA	0.309700	-0.135621	0.354023	0.175616	0.370187
	0.0811	0.5344	0.0443	0.6621	0.0349
Fat:					
Total	1.000000	0.718916	0.888830	0.211276	0.656944
	0.0000	0.0001	0.0001	0.2443	0.0001
% RDA	0.718916	1.000000	0.492941	-0.147411	0.472509
	0.0001	0.0000	0.0044	0.5740	0.0064
Saturated	0.888830	0.492941	1.000000	0.619429	0.685674
	0.0001	0.0004	0.0000	0.0003	0.0001
S/U	0.211276	-0.147411	0.619429	1.000000	0.257849
	0.2443	0.5740	0.0003	0.0000	0.1508
Cholesterol	0.656944	0.472509	0.685074	-0.257849	1.000000
	0.0001	0.0064	0.0001	0.1508	0.0000
Serum Cholesterol	0.250839	0.218132	0.068527	-0.394988	0.166472
	0.2143	0.2843	0.7384	0.0434	0.5786
Serum Triglyceride	-0.359959	-0.185779	-0.318483	-0.083219	-0.353044
	0.0621	0.6441	0.1019	0.6826	0.0677
Activity:					
Aerobic	-0.169745	-0.452948	-0.055917	0.229194	-0.135394
Pts.	0.6446	0.0090	0.7588	0.2046	0.5336
Class	-0.157624	-0.254328	-0.051258	0.266524	-0.408416
	0.6071	0.1568	0.7770	0.1368	0.0362
Physical Fitness:					
VO_2 Max	-0.049629	-0.169596	0.098133	0.363817	0.021370
	0.7835	0.6442	0.5993	0.0384	0.9035
Class	-0.208832	-0.152655	-0.126565	0.105951	0.012039
	0.2501	0.5911	0.5032	0.5705	0.9464

TABLE XVII (Continued)

	Blood Serum		Activity		Physical Fitness	
	Choles.	Triglyc.	Aer.Pts.	Class	VO_2 Max	Class
Age	0.275710	-0.072540	-0.288138	0.072755	-0.369310	0.030138
	0.1698	0.7195	0.1062	0.06944	0.0354	0.8642
Calories:						
Total	0.132671	-0.375605	0.552112	0.149971	0.260495	0.032665
	0.5249	0.0508	0.0014	0.5824	0.1464	0.8533
% RDA	0.155406	-0.405198	0.487117	0.191262	0.139812	-0.056333
	0.5456	0.0340	0.0049	0.2946	0.5486	0.7572
Protein:						
Total	0.369846	-0.237242	0.498547	-0.085453	0.240111	-0.178343
	0.0600	0.2317	0.0039	0.6466	0.1827	0.6701
% RDA	0.370036	-0.237537	0.498459	-0.085286	0.240263	0.177641
	0.0599	0.2311	0.0039	0.6473	0.1824	0.6681
Fat:						
Total	0.250839	-0.359959	-0.169745	-0.157624	-0.049629	-0.208832
	0.2143	0.0621	0.6446	0.6071	0.7835	0.2501
% RDA	0.218132	-0.185779	-0.452948	-0.254328	-0.169596	-0.152655
	0.2843	0.6441	0.0090	0.1568	0.6442	0.5911
Saturated	0.068527	-0.318483	-0.055917	-0.051258	0.098133	-0.126565
	0.7384	0.1019	0.7588	0.7770	0.5993	0.5032
S/U	-0.394988	-0.083219	0.229194	0.266524	0.363817	0.105951
	0.0434	0.6826	0.2046	0.1368	0.0384	0.5705
Cholesterol	0.166472	-0.353044	-0.135394	-0.170288	0.021370	0.012039
	0.5786	0.0677	0.5336	0.6463	0.9035	0.9464
Serum Cholesterol	1.000000	0.104806	-0.169679	-0.408416	-0.162772	-0.531509
	0.0000	0.6160	0.5880	0.0362	0.5677	0.0053
Serum Triglyceride	0.104806	1.000000	-0.222004	-0.237793	-0.164934	-0.267258
	0.6160	0.0000	0.2650	0.2306	0.5841	0.1748
Activity:						
Aerobic Pts.	-0.169679	-0.222004	1.000000	0.445211	0.504618	0.273426
	0.5880	0.2650	0.0000	0.0103	0.0035	0.1264
Class	-0.237793	-0.204651	0.445211	1.000000	0.265130	0.450080
	0.2306	0.2688	0.0103	0.0000	0.1390	0.0095
Physical Fitness:						
VO_2 Max	-0.162772	-0.164934	0.504618	0.265130	1.000000	0.507357
	0.5677	0.5841	0.0035	0.1390	0.0000	0.0033
Class	-0.531509	-0.267258	0.273426	0.450080	0.507357	1.000000
	0.0053	0.1748	0.1264	0.0095	0.0033	0.0000

APPENDIX H

RESULTS OF INDIVIDUAL SUBJECTS' SELECTED

NUTRIENT INTAKE AND BLOOD LIPID

ANALYSIS

Subject No.	Age	Calories		Protein		Calcium		Iron		Vit. A		Thiamine		Riboflavin		Niacin		Ascorbic Acid		Fat		Sat./ Unsat Ratio	% Fat	Chol. (mg)	Blood Analysis	
		Avg.	% RDA	Avg. (gm)	% RDA	Avg. (mg)	% RDA	Avg. (mg)	% RDA	Avg. (IU)	% RDA	Avg. (mg)	% RDA	Avg. (mg)	% RDA	Avg. (mg)	% RDA	Avg. (mg)	% RDA	Total (gm)	Sat. (gm)				Chol. (mg/100 ml)	Trig. (mg/100 ml)
01	60	2104	80.9	99.6	153.2	946	118.2	17.50	175.0	5776	115.5	1.16	89.2	2.00	117.7	16.7	98.2	105	174.2	87.51	27.10	44.86	37.43	517	152	45.6
04	42	2015	77.5	83.0	127.7	1289	161.1	9.78	97.8	6095	121.9	1.01	77.7	1.96	115.3	11.7	68.8	117	195.0	84.80	36.18	74.41	37.87	303	90	67.6
05	44	2582	99.3	89.3	137.3	1222	152.8	14.65	146.5	7241	144.8	1.29	99.2	2.13	125.3	16.03	94.3	208	346.3	75.11	27.44	57.56	26.18	159	130	152.1
06	34	2742	97.9	148.0	227.7	1829	228.7	15.70	157.0	7450	149.0	1.06	75.7	3.13	184.1	27.48	152.7	61	101.7	140.68	58.04	70.23	46.18	1149	110	103.0
07	38	1734	66.7	69.3	106.5	874	109.3	9.45	94.5	5769	115.4	1.25	96.2	1.53	90.0	14.03	82.5	141	235.0	68.73	23.92	53.38	35.67	161	86	180.2
09	31	3511	125.4	173.9	267.5	1774	221.8	21.53	215.3	6083	121.7	1.78	127.1	3.52	207.1	23.91	132.8	276	460.4	69.90	26.44	60.84	17.92	221	110	58.6
10	62	2379	99.1	99.8	153.5	1183	147.9	15.20	152.0	6575	131.5	1.50	125.0	2.03	119.4	18.50	132.1	81	135.0	109.50	45.25	70.43	41.42	491	112	78.6
11	41	2350	90.4	120.8	185.8	997	124.6	14.68	146.8	6097	121.9	1.36	104.6	2.21	130.0	20.50	120.6	70	117.1	120.19	44.56	58.92	46.03	643	137	78.7
12	59	1613	67.2	111.8	172.0	1259	157.4	15.86	158.6	4649	93.0	1.03	85.8	2.05	120.6	23.20	165.7	140	232.9	38.83	9.88	34.13	21.67	206	120	139.6
13	47	2081	80.0	76.0	116.9	956	119.5	11.23	112.3	12370	247.4	1.28	98.5	1.93	113.5	17.05	100.3	253	421.3	75.36	26.69	54.84	32.60	302	92	50.6
14	61	2015	84.0	119.8	184.2	873	109.1	23.08	230.8	5820	116.4	1.19	99.2	1.84	108.2	30.23	215.9	121	202.1	81.13	27.00	49.88	36.24	324	133	126.9
15	50	2102	80.9	77.7	119.5	1065	133.2	17.59	175.9	14858	297.2	1.82	139.9	1.97	115.9	21.95	129.1	285	475.7	60.91	22.50	58.58	26.08	146	94	173.6
16	44	2673	102.8	130.8	201.2	1288	161.6	31.35	313.5	6788	135.8	2.21	170.0	2.37	139.4	27.40	161.2	160	267.1	122.80	42.67	53.25	41.34	545	124	69.8
17	38	2398	92.2	85.8	131.9	459	57.4	16.15	161.5	2456	49.1	1.18	90.8	1.29	75.9	20.13	118.4	84	140.0	106.39	33.03	45.02	39.93	302	112	72.2
18	52	1817	69.9	101.5	156.2	662	82.7	18.60	186.0	8889	177.8	0.95	73.1	1.33	78.2	19.08	112.2	131	218.3	72.11	24.09	50.17	35.71	208	124	161.5
19	33	1484	53.0	52.5	80.8	405	50.6	9.73	97.3	2448	49.0	0.95	48.2	0.82	48.2	12.55	69.7	185	308.8	58.94	17.44	42.02	35.76	162	105	123.7
20	38	2254	86.8	94.4	145.3	1223	152.8	18.25	182.5	10526	210.5	1.68	129.2	1.64	96.5	17.35	102.1	235	391.3	80.43	32.20	66.76	32.12	337	-	-
21	52	1435	55.2	91.5	140.8	392	49.0	14.33	143.3	3769	75.4	0.72	55.4	1.23	72.4	15.73	92.5	134	222.5	83.86	19.44	30.18	52.60	454	-	-
24	53	2250	86.5	98.5	151.6	802	100.2	19.62	196.2	13919	278.4	1.16	89.2	1.73	101.8	15.93	93.7	207	345.2	94.83	30.88	48.29	37.94	850	123	83.5
25	55	2239	93.3	76.8	118.2	1023	127.8	17.04	170.4	25477	509.5	1.15	95.8	3.39	199.4	25.68	183.4	147	245.0	78.92	23.88	43.54	31.72	314	89	65.7
27	37	2250	80.4	133.5	205.4	2237	279.6	16.21	162.1	3545	70.9	1.77	136.2	3.41	200.6	15.89	93.5	50	82.5	66.33	19.13	40.53	26.53	250	141	188.2
29	44	1967	75.6	63.3	97.3	630	78.7	11.15	111.5	7708	154.2	1.03	79.2	1.17	68.8	12.45	73.2	100	167.1	96.63	28.64	42.12	44.22	408	-	-
31	40	1761	67.7	80.3	123.5	889	111.2	11.13	111.3	3271	65.4	0.89	68.5	1.70	100.0	12.60	74.1	128	213.3	51.30	19.00	58.82	26.22	268	92	227.5
35	50	2559	98.4	104.0	160.0	754	94.3	15.70	157.0	9665	193.3	0.83	63.8	1.39	81.8	12.53	73.7	74	122.9	102.93	29.55	40.27	36.20	175	119	74.0
36	54	2513	96.7	90.0	138.5	1028	128.5	13.05	130.5	5154	102.5	1.07	82.3	2.16	127.1	14.98	88.1	72	120.4	104.75	34.94	50.05	37.51	533	112	63.3
37	48	2114	81.3	76.8	118.1	1021	127.6	12.50	125.0	4486	89.7	1.04	80.0	1.72	101.2	14.45	85.0	132	220.0	93.88	31.00	49.30	39.97	200	140	330.2
38	49	2047	78.7	92.4	142.2	751	93.8	14.50	145.0	10191	203.8	1.07	82.3	1.49	87.6	25.83	151.9	93	154.2	90.41	28.06	45.00	39.75	363	-	114.3
39	46	2001	77.0	90.8	139.8	740	92.5	14.24	142.4	3846	76.9	1.01	77.7	1.14	67.1	24.02	141.3	140	233.1	81.96	23.19	39.46	36.85	258	138	83.4
43	34	2717	97.0	112.4	172.9	784	98.0	16.87	168.7	3447	68.9	1.44	102.9	1.72	101.2	29.49	163.8	195	325.0	106.77	35.39	49.58	35.37	491	120	97.8
44	43	2644	101.7	102.8	158.1	1286	160.7	14.54	145.4	3722	74.4	1.37	105.4	2.30	135.3	16.53	97.2	92	153.3	105.33	40.92	63.53	35.85	295	-	-
46	41	2085	80.2	105.8	162.7	720	89.9	11.45	114.5	5593	111.9	1.30	100.0	1.43	84.1	42.75	251.5	805	134.2	114.50	29.75	35.10	49.42	197	-	-
47	58	2282	95.1	107.6	165.6	1152	144.0	12.86	128.6	8957	179.1	1.38	115.0	2.21	130.0	22.48	160.6	116	194.1	97.19	30.18	45.04	38.33	447	144	146.2

VITA[2]

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